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APPLIED HYDRAULICS

THE MAGAZINE OF FLUID POWER
including Air Controls, Air Circuit Design and Electrical Controls...

Electro-Hydraulic Servo Systems
. . . page 66

Porous Metal Filters
. . . page 76

Pneumatic and Hydraulic Controls for Fluid Motor Drives
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Pump Control Servo for Ship Steering Gear
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Fluid Properties for Servomechanisms
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. . . page 119

MAY 1956

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See page 150

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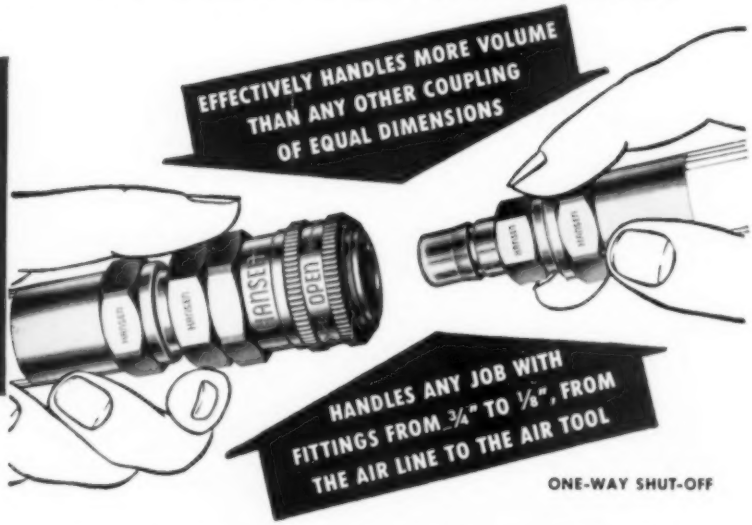
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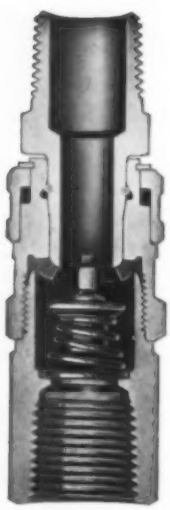

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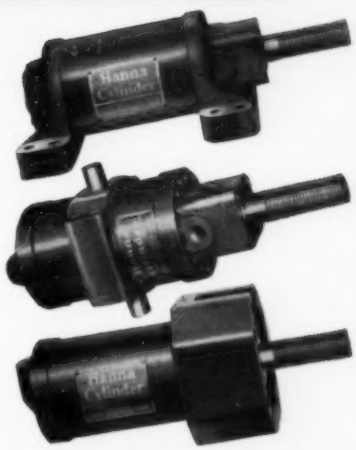

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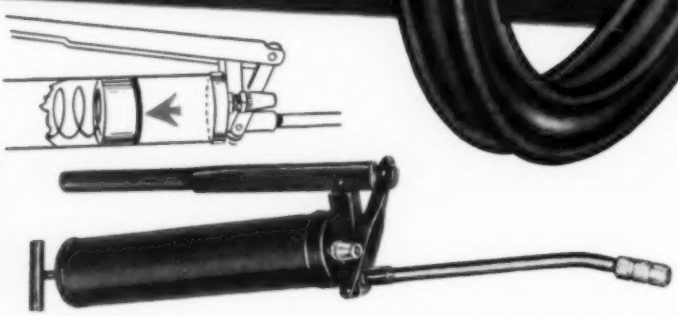

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THE MAGAZINE OF FLUID POWER

MAY 1956
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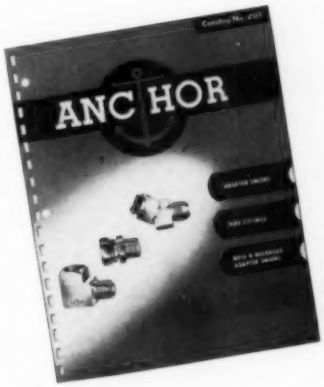
Useful Literature

IMPORTANT DATA ABOUT THE NEW S.A.E. STRAIGHT THREAD FITTINGS BY ANCHOR



A new, complete line of S.A.E. Straight Thread "O" Ring Boss Type Fittings has been announced by the Anchor Coupling Co. Inc. Danger of thread distortion or damage to valve bodies is eliminated by the straight-thread design. Use of an "O" Ring seal insures a positive, leakproof seating with only normal tightening. They may be loosened and retightened many times without impairing efficiency. These new S.A.E. Straight Thread Fittings are fully described and illustrated in the new 36 page Anchor Catalog No. 201, including dimensional diagrams, cross-sectional views and engineering data. Also covered in this Catalog, is the complete Anchor Line of Adapter Unions, Pipe Fittings and standard Boss & Bulkhead Adapter Unions. The Catalog No. 201 may be obtained by writing to the Anchor Coupling Co. Inc., 356 North Fourth Street, Libertyville, Illinois.

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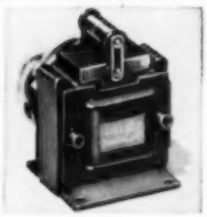

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Fluid Power Lines

about Applied Hydraulics

FROM MACHINE TOOLS TO AIRCRAFT . . . The idea behind this month's cover is—servosystems are an important part of equipment design in all industries.

"What's the future of fluid power in servosystems?" Our, not very quantitive answer is, "Golly, gee, it's big."

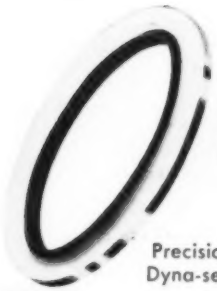
The big key to the use of servos is the equipment designer. And he's the fellow who is just beginning to get his feet wet. As servo terminology and techniques get out of the realm of the mathematician and scientist, the machine designer will be the one who opens up new applications. Greater demand for servo components will lead to standardization and lower costs. The big job is to spread servo knowledge far and wide. That's our purpose in this issue. There are articles discussing operating fundamentals, servo construction, and applications.

SUPER FINE FILTRATION . . . Close tolerance servo valves really make the user filter conscious. Dirt particles smaller than 10 microns can raise havoc. One approach to fine filtration is the use of porous metal filters. Ed Kane's article describes porous stainless steel filters developed for high temperature aircraft circuits.

BASIC SERVOSYSTEMS . . . Wes Broome's lead article in this issue does an excellent job of explaining feedback, and the combination of electronics and high power control. Wes heads the automation section at Raytheon, a company whose development work has resulted in packaged electronic controls for hydraulic systems. After Wes discussed this development work at an NCIH meeting, we approached him to prepare this article. It's an eleven step story which describes each element in the servosystem and shows how they are combined for use in two applications.

J. W. Broome

YOU'LL LEARN A NEW VOCABULARY . . . when you study performance of servo valves used in electro-hydraulic servomechanisms. To deal with new concepts in this, as well as other new areas of development, engineers must create new words, and we've included a glossary of terms in the article on servo valves beginning on page 71. To prepare this article we called on leading manufacturers and developers of electro-hydraulic servo valves to contribute material on their designs. Cooperating on this project were Robert E. Kolp and J. C. Pennell, Cadillac Gage; Irving Kotlier, Hydraulic Controls; Donald G. O'Brien, Midwestern Instruments; L. H. Geyer, Moog Valve; and Kenneth S. Knapton Jr., Sanders Associates. More articles on specific servo valve applications will appear in future issues.



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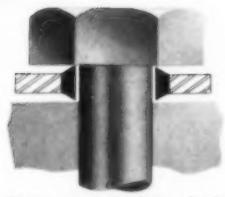
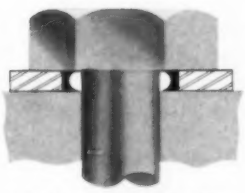
solve countless sealing problems



Dyna-seal before bolt head is drawn down



Bolt head drawn down —with pressure applied

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Vibration Proof, Lock Washer Action

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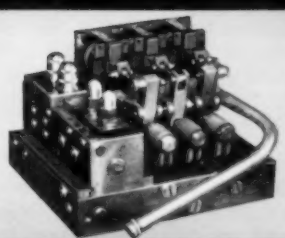

30 Dyna-seals solve plug-leakage problem on The NATCO Hydraulic Control Unit manifold.

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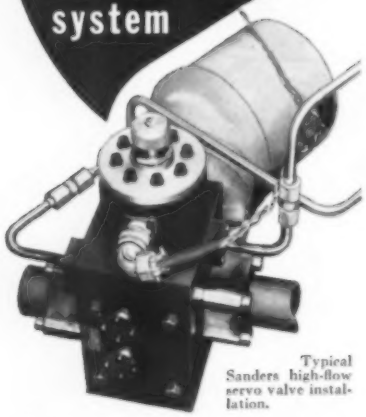

Typical Sanders high-flow servo valve installation.

In the development of automatic control systems involving position, velocity or force, Sanders Associates maintains a completely equipped electro-mechanical and hydraulic laboratory devoted to systems engineering.

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- Rocket and jet engine fuel control systems.
- Widely varied process control systems.

*T. M. Sanders Associates

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Fluid Power Lines

continued

VALVE VS PUMP . . . The article in this month's Aviation Section gives some help to the user who is concerned about choosing between a servo controlled pump and a servo valve. The choice isn't clear cut. Each has its advantages and limitations. L. D. Taylor, a Vickers staff engineer, charts a comparison between the servo valve and servo pump systems.

ELECTRICAL ANALOGY . . . John Fawcett's article explains tracer servos by the use of the electrical analogy. Since this approach is at least twenty years old it has helped and will help many designers to better understand servo circuits.

SCOTCH TAPE CONTROL . . . "We look with hope toward the day when the average mechanical engineer can choose a hydraulic drive and a suitable control system from catalogs, install them with confidence, and then merely adjust the dials on the controls to bring the system to stability with maximum response." To this hope, voiced by Milton Malmquist, whose article starts on page 80, every designer can say "Me too."

M. G. Malmquist

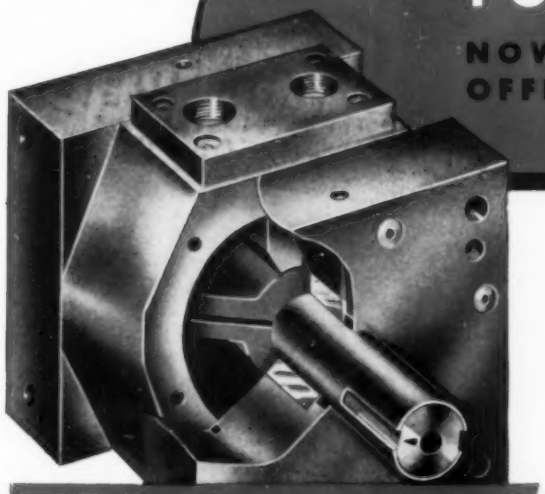
One large processer of web materials, Minnesota Mining and Manufacturing Company, has done a lot of work designing suitable drives. Malmquist's article describes four different control circuits.

AN OLD TYPE SERVO . . . To round out our coverage of servos, H. W. Hamm's article explains the "old fashion" flyball governor to give mechanical control to servo valves. We were told by Mr. Hamm that this control does not necessarily lack the sensitivity, response and versatility of modern electrohydraulic servos. The system has been used for many years to control the speed of prime movers. The article may lead you to consider this type of control for other applications.

OIL FOR SERVOS . . . Here's another item which the user of high response servos must consider. Fluids for servos need special properties in addition to standard qualities of good lubricity, high viscosity index, stability, etc. L. B. Taplin discusses these special properties on page 116.

New ROTO-MATION TORQUE MOTOR

NOW OFFERS 4 COST-CUTTING ADVANTAGES



For Oil or other Pressure Mediums.
Pressure Against Vane Reciprocates Shaft.

TYPICAL TORQUE RATINGS (IN.-LBS.)
Single Vane Units—280° Arc both directions

BORE SIZE	Vane Length	100 PSI	500 PSI	1000 PSI	WT. LBS.
3"	2"	150	750	1500	15
	4"	300	1500	3000	21.5
	6"	450	2250	4500	28
6"	3"	1000	5000	10,000	92
	6"	2000	10,000	20,000	104
10"	5"	5000	25,000	50,000	286
	8"	8000	40,000	80,000	312
	12"	12,000	60,000	120,000	387
20"	6"	30,000	150,000	300,000	1620
	12"	60,000	300,000	600,000	2100

NOTE: Double Vane Units double torque with same pressures, but rotation is limited to 100° in both directions.

✓ **HIGHER TORQUE OUTPUT**—special neoprene and teflon vane seals minimize leakage . . . insure greater power. Speeds limited only by fluid pressure volume. Full torque power obtainable in fraction of a second.

✓ **GREATER OPERATING EFFICIENCY**—through superior design of special vane seals and close tolerance fitting of all parts. Operates at 95 to 98% efficiency, withstands heat up to 200°F. Special models and seals for higher temperatures.

✓ **SIMPLE, ECONOMICAL APPLICATION**—eliminates complex linkages, sprockets, chains, cylinders. Saves space. Applicable to turning, opening, closing, clamping, indexing, feeding, pushing, or moving any type of load or mechanism.

✓ **LONGER SERVICE LIFE**—fewer moving parts, precision machined components, bronze nut and thrust bearings, chrome vanadium and chrome-moly steel shafts. No external leakage.

COMPACT, RUGGED, ADAPTABLE TO A WIDER RANGE OF APPLICATIONS

The new ROTO-MATION Oscillating Torque Motor is a simple, more versatile hydraulic-pneumatic device especially designed to produce more torque power (1,800,000 in.-lbs. from 20" bore) to serve a wider variety of automation applications. Compact and rugged, the new motor is easily adaptable to original equipment or as a replacement unit. Wide ports and flange-type connections meet J.I.C. standards. Extensive tests prove that performance life is many times greater than any device previously manufactured. The square shape facilitates easy mounting on any of six faces. There are 14 mounting models available and four shaft styles. Units are complete with standardized controls, fittings, and auxiliary devices. Sizes are available for moving loads ranging from a few ounces to many tons.

Write **FOR COMPLETE SPECIFICATIONS**—New catalog provides complete specifications, illustrates and describes wide variety of applications, and contains complete torque load graphs.

ROTO-MATION INC.

NOW A SUBSIDIARY OF PINES ENGINEERING CO., INC.

943 E. SATER STREET • GREENVILLE, OHIO

MANUFACTURERS OF ROTO-MATION MOTORS, CONTROLS, AND AUXILIARY TRANSMISSION EQUIPMENT

Designers and Engineers... Clip these reminders to specify

Eastman
first in the field

HYDRAULIC HOSE ASSEMBLIES

Stop torsional strain with Eastman ADAPTER UNIONS

Straight and Angled Adapter Unions

Eastman Design and Engineering Guarantees Tight Fit . . . Easy Action

● **Eastman Adapter Unions** prevent twisting and assure proper positioning of hose lines when being installed. Accurate machining assures leakproof metal-to-metal seat as effective as a ground joint union.

● **Eastman Angled Adapter Unions** eliminate the use of elbows and pipe unions, thereby reducing the number of threaded connections. Original Eastman design provides tight-fitting joint at any pressure.

● **Eastman, "First in the Field of Hydraulic Hose Assemblies,"** stands for the highest quality of material and workmanship—your best assurance of satisfactory service.

"Safeguarding Industry's Lifelines of Mobile Power"

EASTMAN MANUFACTURING CO.
Since 1914
Dept. PE54, Manitowoc, Wisconsin

Eastman
first in the field
HYDRAULIC HOSE ASSEMBLIES

Send for Eastman Form No. 231-B, 232-B for sizes, angles available.

Specify Eastman HYDRAULIC HOSE ASSEMBLIES

● Profit from Eastman's 26 years' experience in Hydraulic Hose Assemblies. Pressed-on, re-usable and renewable couplings and insert type fittings for high and low pressure air, gas, water, paint, grease and hydraulic hose...from ⅛" to 2". Pressure lines up to 5000 psi. Also suction and low pressure units.

WRITE FOR COMPLETE CATALOG OR PHONE YOUR SPECIFICATIONS

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HYDRAULIC HOSE ASSEMBLIES

Write for free catalog 104 on Eastman Hose Couplings and Bulletins 231B & 232B on Straight and Angled Adapter Unions

Eastman
MANUFACTURING COMPANY
Since 1914
Dept. AH-5, Manitowoc, Wisconsin

SAFEGUARDING INDUSTRY'S Lifelines of Mobile Power

LETTERS to the editor

Valve Design

I would like to better acquaint myself with current practice in valve porting, exhaust block design, and construction for solenoid operated 4-way air valves. Can you please advise any good reading on this subject. Also, where can low voltage type solenoids used in valve construction be obtained?

WALTER W. GREEN
270 Lebanon Avenue
Pittsburgh 28, Pa.

To answer your request for reading material on valve design, we have sent you a copy of the Fluid Power Engineering Index. Single copies of this index are available to readers at 50c per copy. We have also sent you a list of companies making solenoids for valves.

What's JIC?

We have been unsuccessful in finding out the significance of the expression JIC Standards. Since these standards are associated with hydraulics can you supply information about the organization which issues these standards and tell us the signification of the standards.

K. G. BROWN
Division Research Librarian
Convair
Fort Worth, Texas

JIC (Joint Industry Conference) Standards were worked out by automotive manufacturers and their suppliers of production equipment and components. At the present time, there are four booklets of JIC standards. They cover: hydraulics, pneumatics, electrical and lubrication. Copies may be obtained by writing: JIC, Box 182 North End Station, Detroit 2, Mich.

The standards were developed and are under continuous study with the aim toward construction

PROVIDES THE *PUSH*
BEHIND THE PUSH BUTTONS

Photos courtesy Herring-Hall-Marvin Safe Company, Hamilton, Ohio

TUTHILL MODEL OOL
Powers Electro-Hydraulic Control
On Automatic Vault Doors

In step with today's automatic age, this unique bank vault door operates by push-button control. To power the electro-hydraulic mechanism that controls this automatic opening and closing operation as well as lowering and raising the foot bridge, H-H-M engineers selected the Tuthill Model OOL, known the world over for its dependable performance.

The dependability so essential for applications like this is engineered into the Tuthill Model OOL. Vertical ports maintain its prime. The mechanical seal contributes to quiet, leak-free performance and low power consumption. Precision manufacture assures constant delivery of capacity required. And as a final guarantee of performance, every Tuthill unit is subjected to the most exhaustive tests before shipment—to make them extra safe for safe service.

TUTHILL PUMP COMPANY
Dependable Rotary Pumps . . . since 1927
939 East 95th Street
Chicago 19, Illinois

Write today for complete data on Tuthill pumps for hydraulic service.

See our catalog in Sweet's Product Design File 6b-Tu

Canadian Affiliate: Ingersoll Machine & Tool Co., Ltd.
Ingersoll, Ontario, Canada

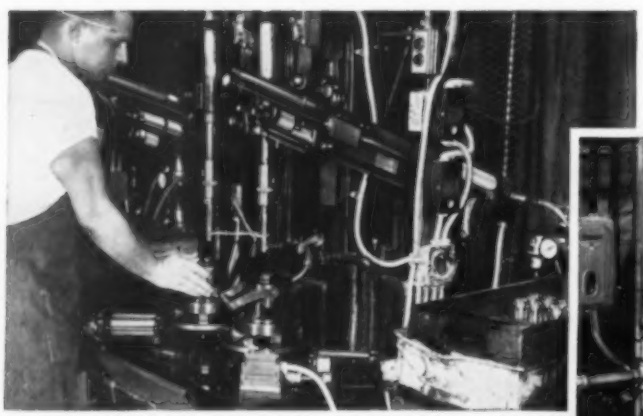
UNIQUE AIR CYLINDER WITH BUILT-IN ELECTRIC VALVE EASILY INSTALLS ON ANY MACHINE

Known as

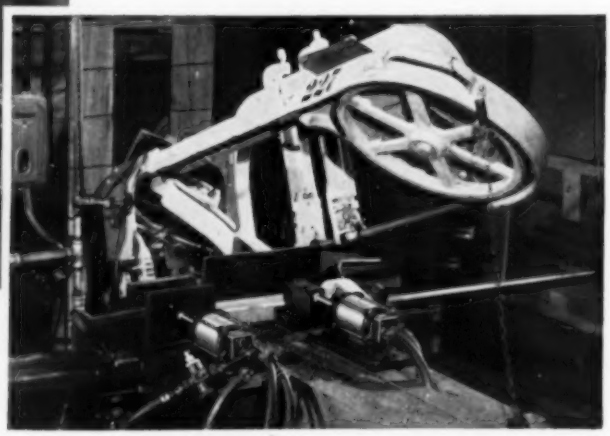
The Bellows Air Motor

it features

- **Built-in Directional Valve**
- **Built-in Speed Controls**
- **Only a Single Air Connection**



Drill Press Feed powered with Bellows Air Motor makes any standard drill press a fast semi-automatic machine.



Standard cut-off saws quickly converted to automatic operation with two Bellows Air Motors.

OFTEN CUTS COSTS 50% OR MORE

Changing a hand fed machine into a fast semi-automatic or automatic unit right in your own tool room is a cinch with the Bellows Air Motor—the unique air cylinder with all controls built-in.

The Bellows Air Motor is a complete work unit in itself. Directional valve, high or low voltage electric valve operating control, and precision speed controls are all built-in. You require only a single air connection—and that can be made with flexible hose.

Two, three—(or as many as you wish) Bellows Air Motors can be electrically interlocked to work in timed sequence to perform related operations with whatever precision you require.

Bellows Air Motors are ruggedly built, precision-machined, to give years of trouble-free service. Records of twenty—thirty, even fifty million cycles are quite common. And Bellows nation-wide service (more than 100 field engineers in industrial areas of the United States and Canada) assures you of quick competent help in the application of Bellows Air Motors to your specific problems.

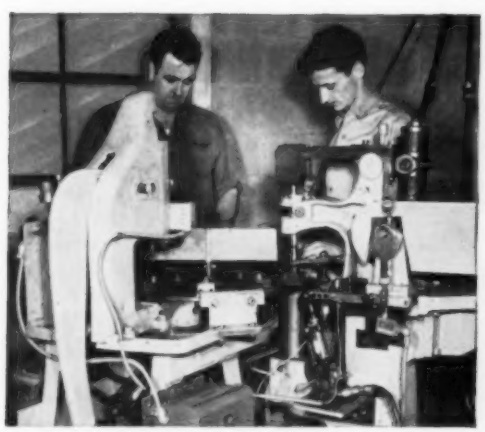
Write TODAY for this NEW four-color booklet

The story of Bellows Controlled-Air-Power and how industry everywhere uses it to find lower-cost ways of doing jobs better. Address **Dept. AH556,** The Bellows Co., Akron 9, Ohio. In Canada: Bellows Pneumatic Devices of Canada, Ltd., Toronto.

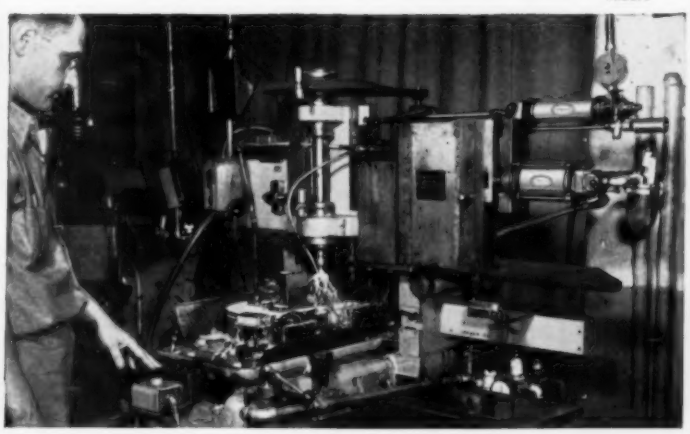
The Bellows Co.

AKRON 9, OHIO

1282A



Kick press powered with Bellows Air Motor equals output of **5** foot-powered presses.



Three Bellows Air Motors turned this obsolete milling machine into a high producing unit.

PAGE PACKINGS
a complete standard line to economically meet your needs
You can save with Page Leather Packings and here's why: They are made of various leathers with treatments or impregnations to best do the specific job at hand. They are tough, pliable, highly resistant to abrasion and wear, so you can depend on them for long life and service.
Page's complete line includes Standard Synthetic Packings . . . U's, V's, Cups, Flanges and O-Rings for various applications and pressures.
And what's more, with Page you not only get well-made packings, but you also get the services and cooperation of qualified packing engineers backed up by a company with 87 years of packing experience and know-how. When you come to Page for packings we can often help you cut basic manufacturing costs as well as packing costs.
Write for Page Packing Catalog today . . . or send us your requirements. Specify Page Packings and you'll save.
PAGE BELTING COMPANY
Established 1868
Concord, New Hampshire
PAGE BELTING CO.
TRADE MARK
It will pay you to specify
PAGE PACKINGS
Engineered to do a better job

LETTERS to the editor

of equipment which is reliable, safe, easy to maintain and uniform in many respects.

JIC, as its name implies, is an open forum of manufacturers and suppliers. These standards have gained wide acceptance. A very significant part of the standards is the drawing symbols for hydraulic, pneumatic and electrical diagrams.

Thread Protectors

Please send names of manufacturers of metal closures. We are experiencing difficulty in maintaining a closure in the cored openings of our hydraulic cylinders. Plastic or synthetic closures will not do the job as somewhere, someone pushes the closures into the cylinders. The result is a costly disassembly operation for our customers.

A. J. LESS
Allis-Chalmers Manufacturing Co.
Cedar Rapids, Iowa

We have sent you names of companies making metal and plastic closures. We believe that there are both metal and plastic closures designed so that someone would have to go out of his way to push the closure into the cylinder port.

Classes in Hydraulics

I am an instructor of hydraulics at the Helicopoter school. I have not been able to find much on the subject of hydraulics. Can you give me an index of material?

Who makes vegetable base hydraulic fluid, what is it made from, and when is it used? Do you think chemical base hydraulic fluids will replace petroleum base?

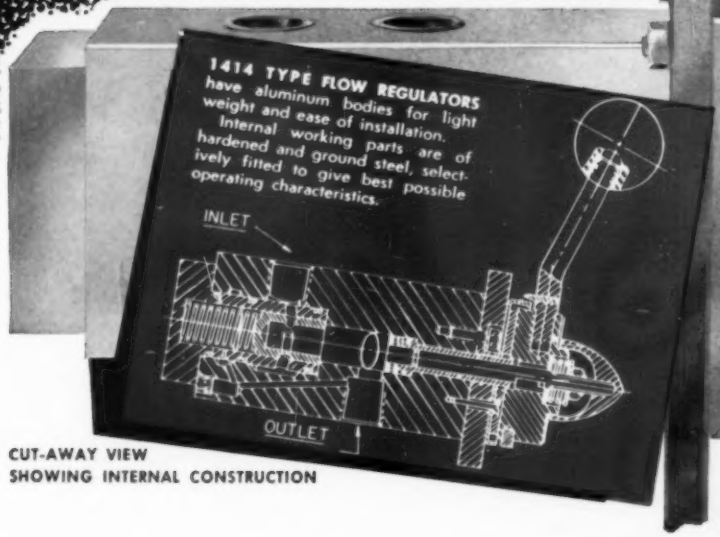
J. C. WEBB
San Marcos, Texas

We have sent you information about the APPLIED HYDRAULICS *Fluid Power Index and the Master Catalog of Fluid Power Products. These books will help you select and secure material for instruc-*

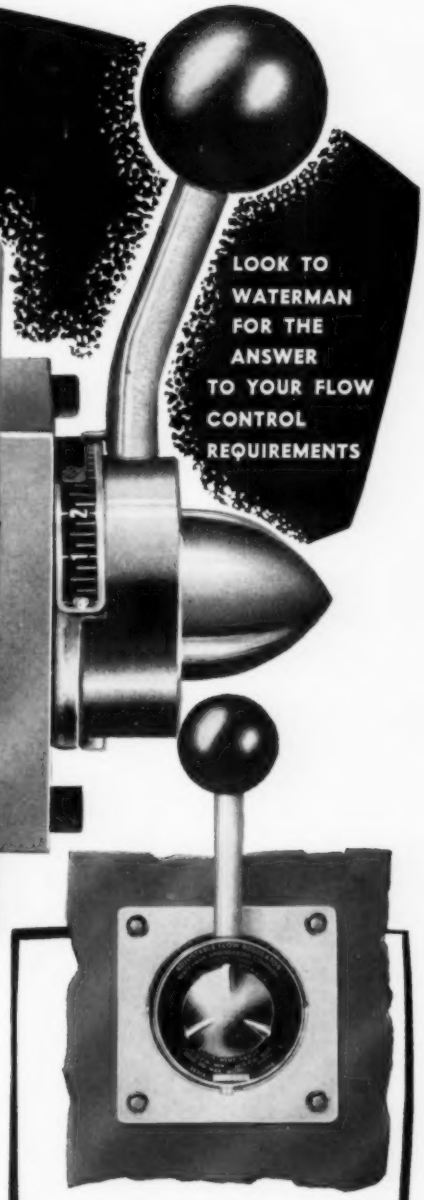
ADJUSTABLE FLOW REGULATOR

Designed for Panel Mounting

LOOK TO WATERMAN FOR THE ANSWER TO YOUR FLOW CONTROL REQUIREMENTS


1414 TYPE FLOW REGULATORS have aluminum bodies for light weight and ease of installation. Internal working parts are of hardened and ground steel, selectively fitted to give best possible operating characteristics.
INLET
OUTLET

CUT-AWAY VIEW
SHOWING INTERNAL CONSTRUCTION



Waterman Engineering Company have combined in this new Adjustable Flow Regulator all the best, improved features . . . at the same time adapting it to Panel Mounting.

Increases the flexibility of your hydraulic systems . . . ideal for installations requiring frequent changes in operating speeds.

Affords a variable adjustment of flow rate over a wide operating range.

Write for illustrated bulletin describing the many features of this Adjustable Flow Regulator such as right or left rotation of control handle, 180° handle rotation, pressure drop, regulated flow tolerance, etc.

WATERMAN

ENGINEERING COMPANY

725 CUSTER AVENUE — EVANSTON, ILLINOIS

When the pressure's on

your best bet is

FLEX-O-TUBE

Supplied in Assemblies

Flex-O-Tube will help you determine the assembly needed or work to your own specifications. In either case, modern facilities and latest inspection techniques assure you a uniformly high quality product delivered promptly.

Supplied for Field Assembly

Flex-O-Tube hose is also supplied in bulk coils with reusable fittings for field assembly. Complete range of sizes and types.

If you use flexible hose in your product or for replacement in your plant, it will pay you to specify Flex-O-Tube. For here is a name that has stood for finest quality and dependable service for more than a quarter of a century.

In the development of new uses for flexible hose, Flex-O-Tube provides you with dependable experience in the field. When used for replacement in industrial maintenance, Flex-O-Tube provides you with a complete range of products that are easy to assemble and long on performance.

Whatever your needs, why not discuss them with the local Flex-O-Tube field engineer. You'll find there are many good reasons why industry has relied on Flex-O-Tube for miles and miles of flexible hose products.

Please send me your free ☐ aircraft catalog. ☐ industrial catalog.

Name .....

Company .....

City ..... Zone ..... State .....

Address .....

FLEX-O-TUBE

DIVISION OF MERIDAN CORP.

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Flex-O-Tube Co. (Canada) Ltd., Windsor, Ontario

LETTERS to the editor

tion in hydraulics. To our knowledge, vegetable base fluids are no longer being used for hydraulic systems. Many aircraft applications use synthetic base hydraulic fluids because of fire-resistance and operating temperatures.

Glycerine in Hydraulics

Can you give me information or suggest someone who could evaluate the extent to which glycerine is used as a hydraulic fluid?

JOHN J. CRAIG
G. M. Basford Company
New York City

Right now, the best we can do is suggest several people with whom you might discuss the use of glycerine in hydraulic systems. Users of water hydraulic systems may be adding a small percentage of glycerine. Perhaps readers can enlighten us further.

Hydraulic Societies

I am a member of the American Rocket Society and would like to have more information on societies dealing with hydraulics such as the National Fluid Power Association. I am interested in a membership to improve my knowledge about hydraulics and pneumatics.

F. E. GRIFFITHS
2165 W. Broadway Ave.
Anaheim, California

The National Fluid Power Association is a trade association of manufacturers. Your best bet for society activity in fluid power, is to investigate the programs of local chapters of ASME and SAE. Some chapters throughout the country are devoting sessions to fluid power.

There is the National Conference on Industrial Hydraulics which holds a two day meeting annually. For information about the 1956 conference see page 46.

▼▼▼

over 8,000 Different Cylinder SELECTIONS—

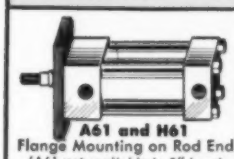
Miller AIR AND HYDRAULIC **CYLINDERS AND BOOSTERS**

"IN STOCK" for immediate delivery..

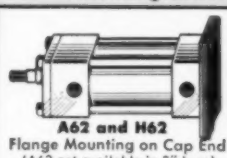
See Miller Bulletins A-105K (Air) and H-104K (Hydraulic) for Complete Dimensions and Engineering Data on these "in-stock" sizes and other Custom Miller Cylinders in bores up to 20" and strokes up to 22 feet.

"IN-STOCK" MODELS

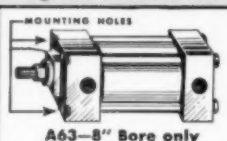
"A" Signifies Miller 200 psi Air Cylinders; "H", 2000 psi Hydraulic Cylinders. Interchangeable Mountings Are Shown In Red On Drawings.



A61 and H61
Flange Mounting on Rod End
(A61 not available in 8" bore)

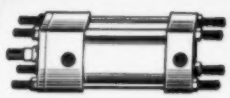


A62 and H62
Flange Mounting on Cap End
(A62 not available in 8" bore)

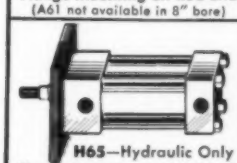


A63—8" Bore only
Flange Mounting on Rod End

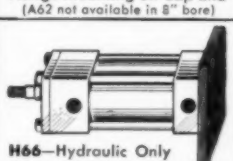
A64—8" Bore only
Flange Mounting on Cap End



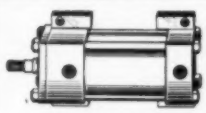
A50 & H50—Tie Rods not extended beyond nuts.
A51 & H51—Tie Rods extended both ends (shown).
A52 & H52—Tie Rods extended. Cap End only.
A53 & H53—Tie Rods Extended. Rod End only.
A54 & H54—Two Tie Rods extended at both ends.



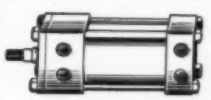
H65—Hydraulic Only
Flange Mounting on Rod End



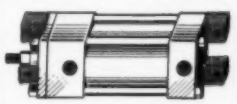
H66—Hydraulic Only
Flange Mounting on Cap End



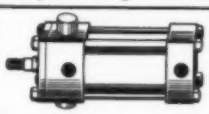
A72 and H72
Side Lug Mounting



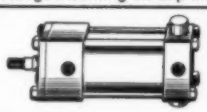
A74 and H74
Side Flush Mounting



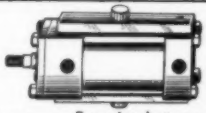
A77 and H77
Side or Foot Mounting



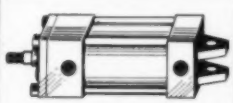
A81 and H81 Trunnion Mounting on Rod End



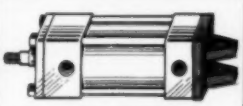
A82 and H82 Trunnion Mounting on Cap End



A83 and H83 Trunnion between Head and Cap (one week delivery)



A84 and H84
Pivot Mounting



A86 and H86
Pivot Mounting

IN STOCK BORES in Inches — "IN-STOCK" STROKES (in Inches)

	Bores	Rod Dia.	Rod Turn Down & Threads		1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
AIR	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	6	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	8	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
HYDRAULIC	1½	⅝"	7/16-20	Cushioned			3	4	5	6	7	8	9	10	11	12									
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12									
	2	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	2½	1"	¾-16	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	3¼	1⅜"	1-14	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	4	1¾"	1¼-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
	5	2"	1½-12	Cushioned			3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36
				Non-Cush.	1	2	3	4	5	6	7	8	9	10	11	12	14	16	18	20	22	24	28	32	36

① "A" and "H" Models 82, 84 and 86 with strokes over 18" require stop tubes.

Column strength requires larger diameter piston rods for the following:

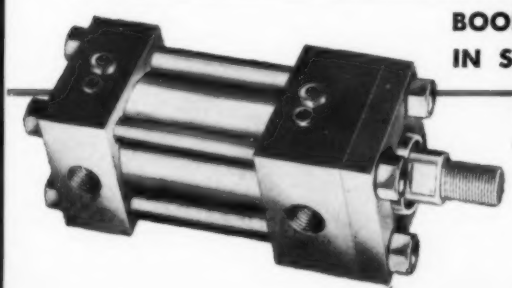
Air Cylinder Models A82, 84, and 86 with strokes inside area (1), when operated at 100 psi and over;

All hydraulic models with strokes inside area (2) and Models H82, 84, and 86 with strokes in area (4), when operated at 2000 psi and over;

Models H82, 84 and 86 with strokes inside area (3), when operated at 1000 psi and over.

Depending upon Trunnion Pin location, "A" and "H" Models 83 with standard diameter piston rods can have longer strokes than Models 82, 84 and 86.

See Miller File #251 for oversize piston rod and stop tube requirements.



BOOSTERS IN STOCK

Immediate Delivery on the following Miller 25 to 1 Ratio Boosters (80 psi air input produces 2000 psi hydraulic oil output): Model B4, 5" bore, 1" dia. ram, 6" and 12" strokes; Reciprocating Booster Model DA77-RBA8, 5" bore, 1" dia. ram, 6" stroke. Also Booster Tanks, 5" dia., 6" and 10" heights.

Write For Catalog and Stock Price List

Miller

MILLER FLUID POWER DIVISION
FLICK-REEDY CORP.

2008 N. HAWTHORNE AVE., MELROSE PARK, ILL.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS

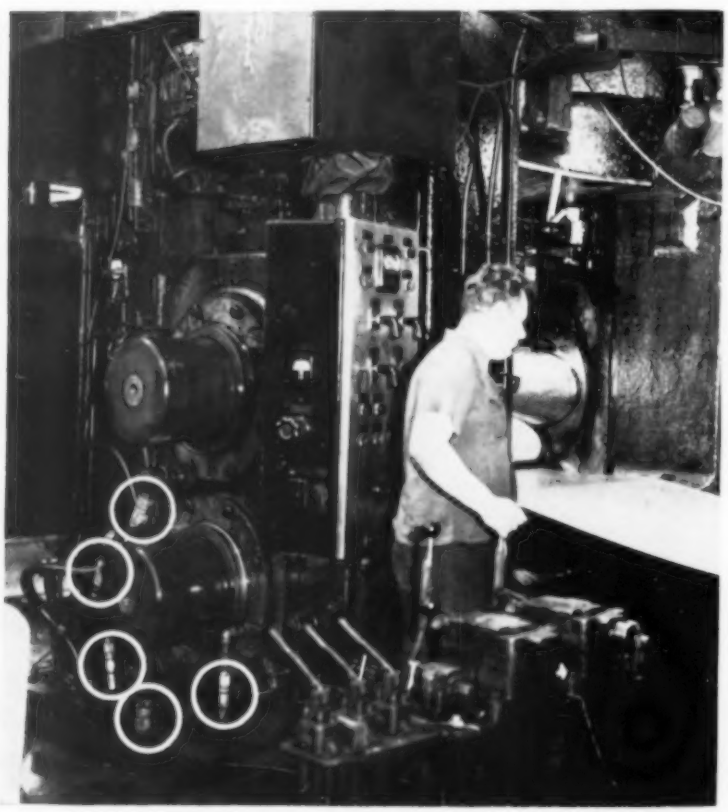
BRIEFS about fluid power

QUICK-CONNECT COUPLINGS INCREASE STRIP ROLLING MILL PRODUCTION

To reduce the downtime required for changing roll mills, Crucible Steel Co., has installed quick-connect hose couplings on its fluid lines. These feed high pressure hydraulic fluid, at 850 psi, and also provide a heavy flow of lubricant to both cool and lubricate the larger bearings of the back up rolls.

As a single stand reducing mill turns out steel sheet at a maximum speed of 800 feet per minute, downtime for roll changes became a costly production loss. In order to maintain a mirror finish on the steel sheet, work rolls have to be changed about twice every eight hour shift. The coupling and uncoupling of fluid lines used to be a troublesome operation when threaded fittings were used which required tightening and loosening with a wrench.

These quick-connect couplings have practically wiped out the heavy downtime loss and have provided trouble-free service under difficult operating conditions. ▼▼▼



More Education In Fluid Power

The urgent need for more formal training is evident from increasing information and requests coming across our desk.

Recognizing this urgent need, the National Conference on Industrial Hydraulics, sponsored by the Illinois Institute of Technology and the Armour Research Foundation offer these courses.

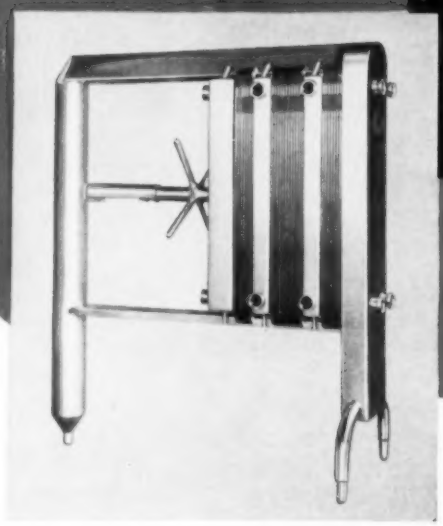
Introduction to Oil Hydraulic Power—non-credit course—covers the basic theory of hydraulic circuit and equipment. It's open to the general public interested in this subject. High school graduation or its equivalent is the only requisite.

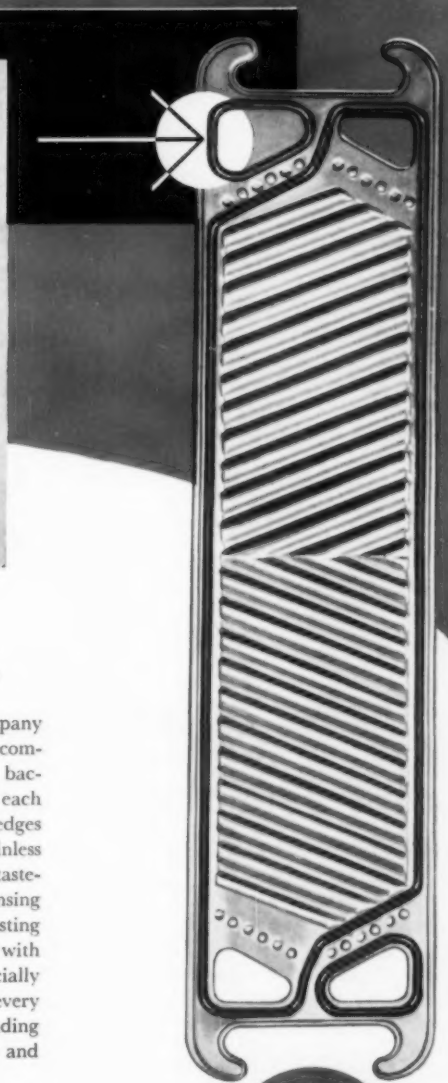
Oil Hydraulic Power—college credit course—offered to college junior and senior students, carries 3 credits. It consists of 2 hours of lectures and 3 hours laboratory per week for fifteen weeks.

Fellowship Program. This leads to a Master of Science de-

Continued on page 22

Critical purity depends on precision processing





C/R MOLDS, BONDS GERM-PROOF PLATE SEAL

First concern of the Kusel Dairy Equipment Company was to provide for exceptional sanitation in the commercial plate heat exchangers they manufacture. Because bacteria can multiply rapidly in the smallest crevice or pocket, each pressure gasket had to be bonded so precisely that no loose edges or imperfections could exist between the gasket and the stainless steel plate to which it is bonded. Also, the gasket had to be tasteless, odorless, able to withstand high temperatures and cleansing solvents; it must resist the action of fatty acids, and possess lasting elasticity for consistent sealing performance. Kusel worked with C/R Sirvene engineers . . . and got the answer. C/R's specially compounded Sirvene (synthetic rubber) material meets every specification . . . including the critical tolerances and bonding precision required to permit the high degree of cleanliness and purity demanded of the dairy industry.

If you have a sealing problem—critical or simple—C/R Sirvene engineers can help you. They're established leaders in the compounding and molding of elastomers for fluid sealing and related applications . . . and backed by the finest research and production facilities to solve your problem quickly, economically. Write them direct, or write for the new booklet, "Sirvene."

CHICAGO RAWHIDE MANUFACTURING COMPANY
1203 Elston Avenue • Chicago 22, Illinois

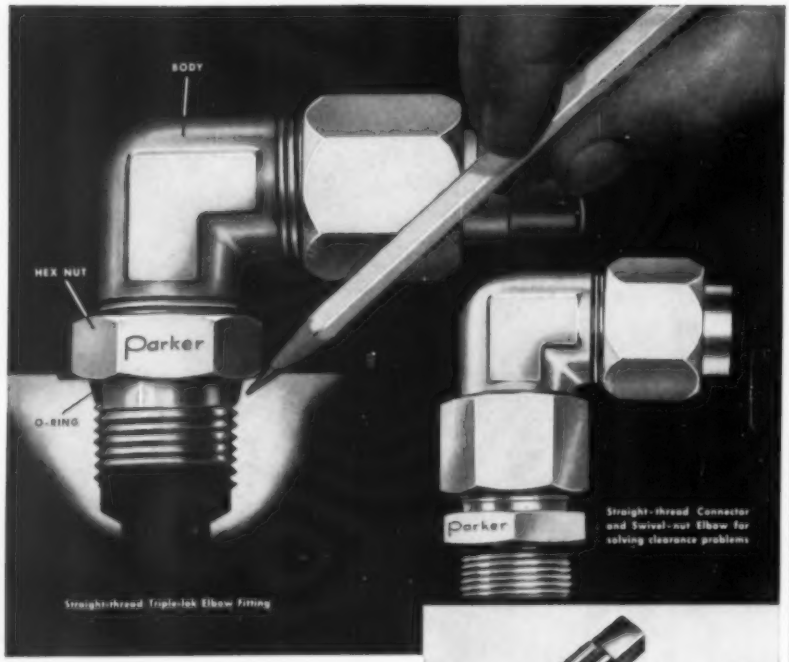
Offices in 55 principal cities. See your telephone book

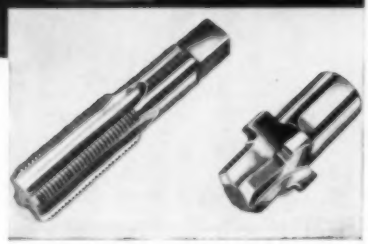
In Canada: Manufactured and Distributed by
Super Oil Seal Mfg. Co., Ltd., Hamilton, Ontario
Export Sales: Geon International Corp., Great Neck, New York

SIRVENE C/R DIVISION

CHICAGO RAWHIDE

Other C/R Products
C/R Shaft and End Face Seals • Sirvis-Conpor mechanical leather cups, packings, boots • C/R Non-metallic Gears





Precision thread-tapping and counterboring tools for making accurate *straight*-thread boss (to receive these new Parker *straight*-thread fittings) are now available with machining drawings from Parker.

New Parker *straight*-thread fittings solve your leakage problems

Now you can forget about high-pressure hydraulic problems resulting from tapered pipe threads. Forget about leakage . . . about the danger of cracking or distorting valve bodies by over-tightening the fittings . . . about damaged threads from over-tightening to obtain proper positioning. Forget about messy pipe "dope".

You can eliminate all of these problems by using new Parker *straight*-thread fittings with positive O-ring seals. (See illustration above.)

Parker *straight*-thread fittings are now being supplied in response to the growing demand for this new type of leakproof, trouble-free connection. They are shorter and have smaller hexes than the AN fitting for the old AND 10050 boss. *Straight* threads are available on *Triple-lok* (the industrial standard flare tube fitting) and on *Ferulok* (flareless fitting for heavy steel tubing).

This is another example of Parker's pioneering leadership in the field of hydraulic fittings. Write for Cat. 4301.

TUBE AND HOSE FITTING DIVISION
Section 414-F
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio

Parker
Hydraulic and fluid system components

BRIEFS / continued

gree. It's offered to a college graduate with a B.S. degree and a grade averaging over 80%. Covers his expense for one year of graduate study with a research project in oil hydraulics.

Basic Oil Hydraulic Power —non-credit summer course—offered from June 11-22, is a full time day program designed for shop, maintenance, operating and sales personnel. This course was fully described in the April issue of APPLIED HYDRAULICS, page 22.

Complete information on the above programs can be obtained from Conference Secretary, National Conference on Industrial Hydraulics, 3300 South Federal Street, Technology Center, Chicago 16, Illinois.

Another course offered . . . by the University of Toledo, as a part of its evening session program in tool engineering is 'Mechanical Engineering—Hydraulic, Pneumatic and Electric Control'. The combination of these three fields of control into one course show that the machine designer of today must have an understanding of all types of motivation and control. The aims of the course are to understand the operation and construction of individual components, so as to be able to select and apply them; to select the best system for operation and control of specific machines, and to know some commercial equipment in each field. ▼▼▼

The Most Recent Advances . .

. . . in the design and use of measurement and control instruments will be featured at the 11th International Instrument-Automation Conference and Exhibit to be held at New York's new Coliseum, September 17-21.

Nearly 300 different companies will exhibit their products and approximately 200 technical papers will be presented at the meetings. A special display will show special

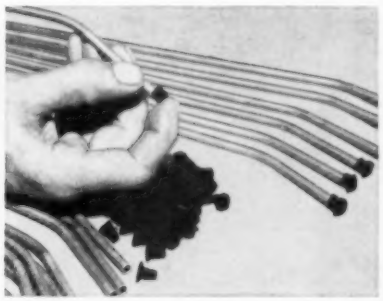
Continued on page 26

Tough, Flexible CaPlugs Are Used in Countless Ways to Protect Products in Process, Storage and Transit

Quick to put on... kind to threads... add sales sparkle

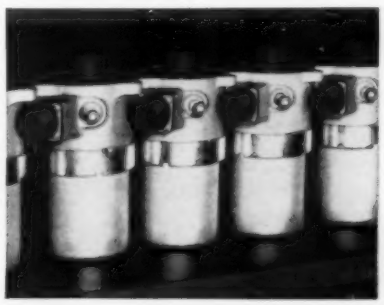
JUST PUSH THEM ON . . . OR PUSH THEM IN

Tapered CaPlugs can be used as caps or plugs, inside or outside of threaded or plain fittings. Costing less to buy, these versatile closures cost less to apply. Time studies show that Tapered CaPlugs save up to 500% in labor costs.



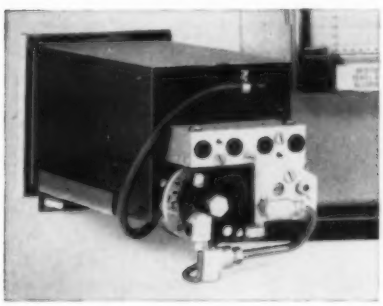
USED BY THOUSANDS OF INDUSTRIES

Here, CaPlugs are applied by Caterpillar Tractor Co., ". . . to protect and keep clean the tubing used in fuel injection equipment for diesel engines." Made of Polyethylene, CaPlugs will not collapse, chip, break or shred under most severe of conditions.



FIT MULTITUDES OF PRODUCTS

CaPlugs protect electrical connector fittings and armature shaft extensions of these electric motor assemblies. Here's sure, safe protection that's adaptable to all types of products and parts. (Photograph courtesy Pesco Products Division, Borg-Warner Corporation)

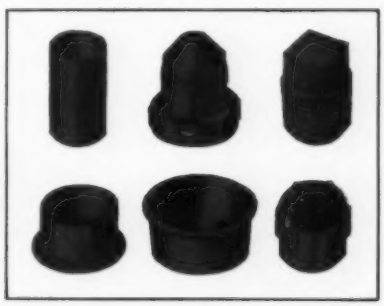


EASY TO REMOVE, TOO!

Installed on these Bristol air control instruments, CaPlugs prevent dirt or foreign matter from getting into the system before installation. Says The Bristol Company, "They are sturdy enough so that they are not accidentally dislodged, but are still easily removable."

INDICATES CARE IN MANUFACTURE

On this Alemite Accumatic Valve, colorful red CaPlugs add zestful eye appeal. Says Stewart-Warner Corp., "CaPlugs help impress the customer with the steps that have been taken to protect the equipment and convince him of the continuing need for protecting lubricants against contamination."



YOU NAME IT

There's a CaPlug to fit nearly every closure need. With six standardized designs (both threaded and non-threaded) and over 275 stock sizes available, "off-the-shelf" deliveries can be made to meet your immediate requirements without delay. Write for free samples and prices.

Free "see-for-yourself" assortment mailed on request

CAPLUGS DIVISION, PROTECTIVE CLOSURES CO., INC.
2203 Elmwood Ave., Buffalo 23, N. Y.

MAIL a free assortment of CaPlugs, literature and prices to us immediately, without obligation.

Name_____ Title _____

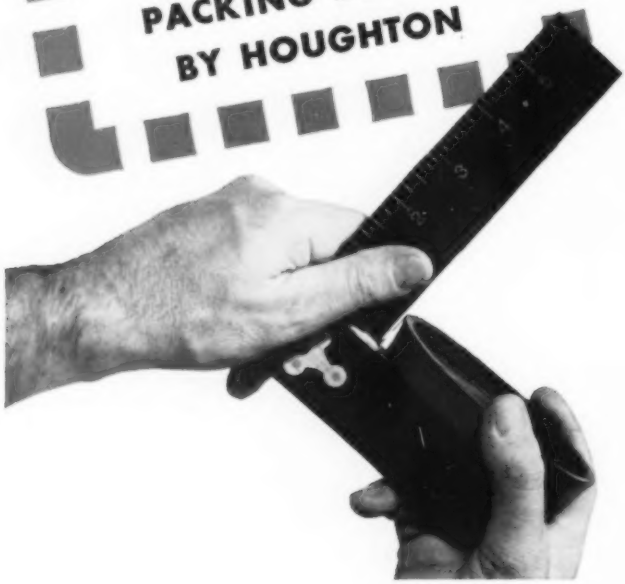
Firm _____

Address _____

City _____ Zone ____ State _____

For the most

NEW DEVELOPMENTS IN PACKING DESIGN BY HOUGHTON



PRE-FORMED
SHOULDER AND FLARE
MAKE CUP PACKINGS
SEAL BETTER

SPRING MOUNTED
CUPS

STANDARD STACK HEIGHT
for "V" Packings

HOMOGENEOUS RUBBER

FABRICATED RUBBER

LEATHER

advanced packing engineering

Call HOUGHTON

Houghton's newly designed leather cup packings are pre-formed. They *fit* the square corner normally found between the end of the piston and the cylinder wall.

As a result, there is no distortion of the packings under operating pressure. They are not forced into a *new* shape which would cause premature wear, fracture or breakdown at the heel. In addition, the sidewalls are molded with a slight flare which provides sufficient pre-loading for perfect sealing at minimum pressures.

Provide Better Seal...Reduce Friction...Increase Life

Houghton hydraulic research has come up with one of the chief answers to the problem of excessive friction, short cup life and chatter so often encountered in cup packing installations. Now, instead of the squeezing action of tightly bolting the cup packing in place between the piston and the follower plate, you can use a low pressure spring mounting which does not deform the cup and cause early failure.

Now we have standardized the stack height of *all* Houghton "V" packings. This means that they are interchangeable with each other in regard to stack height. Whether you use homogeneous rubber, fabricated rubber or leather "V's" . . . they'll fit! You can forget "special" dimensions, set up by various packing manufacturers for particular types of packings.

This leadership in hydraulic know-how is typical of Houghton, which makes all types of hydraulic and pneumatic packings, as well as a complete line of hydraulic oils and fire-resistant fluids.

Standardize on Houghton. You'll get the newest first—and the best always. Call your Houghton Man and let him explain Houghton's Hydraulic Service. E. F. Houghton & Co., 303 West Lehigh Avenue, Philadelphia 33, Pa.

VIX-SYN "O" RINGS

VIM #1243-3 CUP PACKINGS

VIX-SYN "V" PACKINGS

VIM "V" PACKINGS

VIX-SYN "U" CUP PACKINGS

VIM "U" PACKINGS

E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

a new

LOW-PRICED

radial piston pump

Here is a hydraulic pump that provides the high performance characteristic of piston-type pumps—at a price usually associated only with pumps of vane or gear design.

This is made possible by utter simplicity in design, coupled with a revolutionary "shrink seal" feature, and the economical SECO radial design.

The Model D-5 illustrated is rated at 2000 PSI maximum—5 GPM—at 1800 R.P.M. using 235 SSU oil at 100° F. *The over-all efficiency is above 90% for a wide range of operating conditions.*

A simplified feed-back control with external valving can be utilized to accomplish variable displacement—with resulting advantages, such as constant pressure feed-back control, economy in horsepower, etc.

If you use vane or gear type pumps within the range of this new pump, please use the Reader's Service Card for more complete information and prices—

SECO **SERIES "D" PUMP**

SIMPLEX ENGINEERING CO.
ZANESVILLE, OHIO

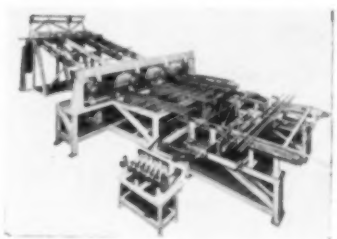
BRIEFS / continued

projects in measurement and control now on the workbenches of eight leading universities. Technical sessions, clinics, workshops and special meetings will take place in the Coliseum, Columbia University, and the Hotels Statler and New Yorker. ▼▼▼

Air-Hydraulic Power Assures High Production Rate

An automatic machine which enables standard heating furnace and roll forging press equipment to preheat and point the ends of 12 feet long and ¾ inch diameter coil spring rod blanks at a rate of 618 rods per hour has been built by Expert Automation Machine Company.

A bundle of coil spring rod stock comes to the machine in a



cradle. Two hydraulic cylinders dump the load onto an inclined ramp where they flow to a selector plate mechanism. The air cylinder controlled selector plate mechanism feeds one rod at a time to a rotary feed device. Both hydraulic dump cylinders and the selector plate mechanism are controlled by the number of rods on the ramp. An air cylinder controlled straight-line feed delivers the rods one at a time to the pointer feed reciprocator where they are clamped by a diaphragm air cylinder. Another air cylinder feeds the rods back and forth into the roll forging and squeeze dies. In the pointing operation the rod is fed into the forging rolls and retracted to a stationery position where the end is squeezed by the air cylinder controlled squeeze die

Continued on page 28

Circle 134 on Reader Service Card

Circle 6 ⟶

NOW FOR THE FIRST TIME

AJAX 3-D Degree

DIHEDRAL COUPLINGS

INTRODUCE TRULY SELF-ALIGNING COUPLINGS

at no extra cost

NEW Ajax 3-D Dihedral Couplings are self-aligning to 3 degrees, yet cost no more than ordinary gear type couplings.

They are designed and built on the same principle used in the D-100 Series Ajax Dihedral Coupling introduced 5 years ago.

The success story of Ajax Dihedral Couplings created an insistent demand for a coupling providing Ajax Dihedral performance on direct-connected equipment where misalignment does not exceed 3 degrees.

Features of the new Ajax 3-D Dihedral Coupling include:

3 degree misalignment capacity.

Load is distributed at center of teeth at the point of greatest strength.

More tooth strength is provided under misalignment than is possible with any other tooth shape.

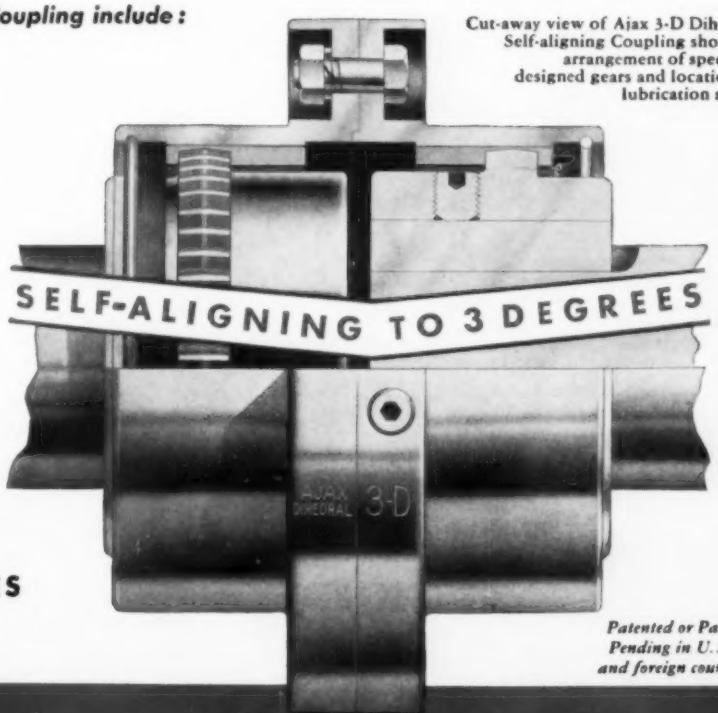
Exclusive Ajax Dihedral tooth design has less clearance than conventional gear type couplings.

No end-of-tooth wear under misalignment. Johns-Manville "Clipper" seals keep lubricant in and foreign matter out.

Compact overall size.

Designed for NEMA motors with standard keys.

Low prices competitive with ordinary gear type couplings.



Cut-away view of Ajax 3-D Dihedral Self-aligning Coupling showing arrangement of specially designed gears and location of lubrication seals.

AVAILABLE IN 5 SIZES

Write for new Catalog No. 60

Patented or Patents Pending in U. S. A. and foreign countries.

AJAX FLEXIBLE COUPLING CO. INC. — **WESTFIELD, N. Y.**

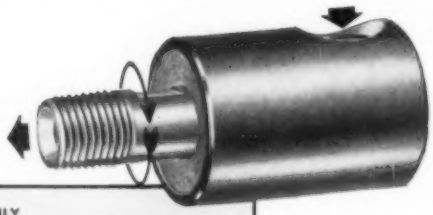
Representatives in Principal Cities

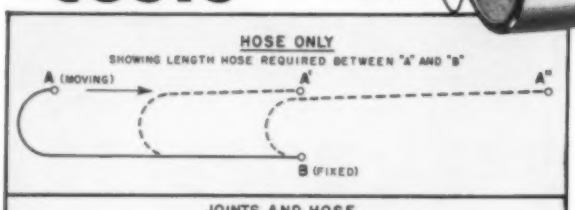
The World's Most Complete Line of Flexible Couplings

SINGLE PLANE

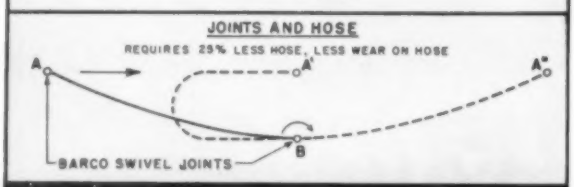
New Barco help cut HOSE COSTS

SWIVEL JOINTS





Straight or Angle Connections



1. Use Shorter Hose Lengths

For Hydraulic or Pneumatic Service

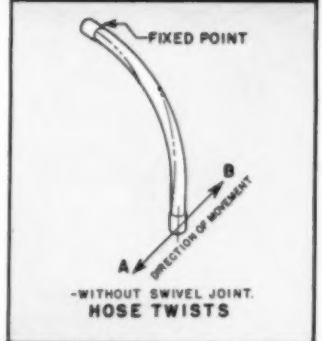
HERE is a real opportunity for product designers and machinery builders to CUT HOSE COSTS. Barco's new Single Plane Swivel Joints are especially suitable for use as *leakproof* flexible connectors (either angle or straight) wherever hose moves, bends, or twists.

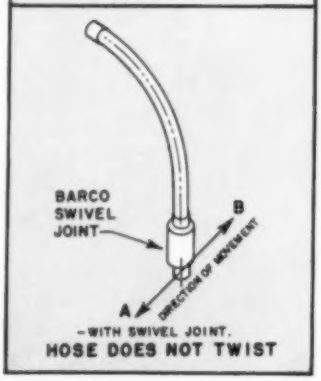
- *Key to Better Engineering!* Often possible to eliminate long radius bends—get neat, space-saving installations (See Fig. 1). Eliminate torsional working stresses that cause fatigue and failure in pressure hose (See Fig. 2).
- *Economical!* These new Barco joints are small, light, and inexpensive. They turn with very low torque under pressure.
- *Sealed, Unitized Construction.* Built with ball-bearing or thrust bearing. O-ring seal. Choice of styles; sizes ¼", ½", ⅜", ¾". For service to 2,000 psi, −20° to 225°F. Other types available for higher ratings.

GET THE FACTS NOW!

For complete information, see our nearest representative, or write. ASK FOR NEW CATALOG SHEET No. 406A.

2. Get Longer Hose Life





BARCO MANUFACTURING CO.

BARCO

532-F Hough Street Barrington, Illinois

In Canada: The Holden Co., Ltd., Montreal

BRIEFS continued

which lines up with the forging rolls. This operation is repeated three times. In the last squeezing operation, the rod end is lifted in the stationery squeezing die position by an auxiliary air cylinder to a position where the part number is marked in. From the rod pointing and marking operation the rods are deposited by an air motor controlled rotary cam mechanism on a cooling chain-type conveyor which directs the rods to a cradle.

A control console operated by the forging press has cam operated valves which sequence all air cylinder control functions. Use of air controlled operations avoids high temperature operating problems. ▼▼▼

Hydraulic Spud Jacking Device

For raising offshore drilling barges effectively, Joe Stine, Inc., designed this new lifting mechanism. Called a hydraulic spud jack, it is used on the offshore barges in various multiples, based on weight

lift and other factors required by the equipment. Each unit has separate controls and central pump system for actuating the hydraulic mechanism. The unit is comprised of hydraulically operated piston, cylindrical housing that locks around spud, conventional slips, pump and controls, with various fluid hose lines. These units, when

Continued on page 30

how would you seal it?

Answer: The "Gask-O-Seal"* at right.

When you have a static sealing design problem why not find out how Franklin C. Wolfe Company's free design service can be of assistance.

FRANKLIN C. WOLFE CO.

"Sealing design specialist"

Culver City, California

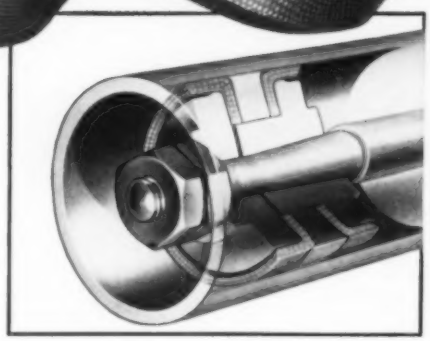
* patent 2,717,793

PUMCUP ADVANTAGES

now yours for

- HYDRAULIC CONTROLS
- AIR CYLINDERS
- RECIPROCATING PUMPS

Two common Pumcup types: conventional and 45° bevel type . . . available in a complete range of sizes and texture-engineered compositions.



Cutaway view of typical Pumcup installation resulting in prolonged high efficiency.

TAKE it from experienced users, Darcova Pumcups offer payoff advantages that can't be equalled! For example, they last many times as long as ordinary piston packing..and they *hold peak efficiency* from start to finish. Because of the resulting production and maintenance economies, plant after plant is standardizing on Pumcups.

Improved application of the cup principle does the trick. And Darcova Pumcups are *texture-engineered* in *a range of compositions* to meet most temperature-pressure-fluid conditions. And they are available in sizes and types exactly right for your particular equipment.

It will pay you to get *all* the facts. Just ask for Pumcup Bulletin No. 5503.

DARLING VALVE & MANUFACTURING CO.
Williamsport 15, Pa.

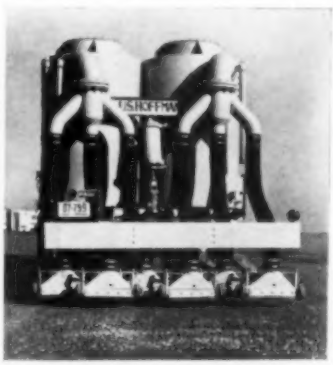
DARCOVA
THE ORIGINAL COMPOSITION CUP
TRADE MARK
PUMCUPS

BRIEFS continued

operated in unison, can raise the equipment quickly and efficiently to any spud height required. The unit shown locked on spud has approximate OD of 30 inches, and when slips are set a 4 foot piston stroke. ▼▼▼

Air Cylinder Positions Cleaning Nozzles

Designed for use on airfield runways handling jet aircraft operations, U.S. Hoffman Machinery Corporation has built this



huge mobile vacuum cleaner. The actual vacuum surface is made up of six ground level nozzles arranged over an eight-foot width at the rear of the vehicle. These are raised by an air cylinder when not in use, or lowered when put into cleaning operation. One man can drive and control the complete unit. ▼▼▼

A Complete Report . . .

. . . on the first annual Contour Machining Conference (APPLIED HYDRAULICS, January 1956, page 28) has been published by True-Trace Corporation, El Monte, California, sponsors of the meeting. The 24 page booklet contains the speeches and panel discussions on recent developments of tracer controlled production methods. The conference highlighted the improvements in aircraft and instrument fabrication, necessitated by difficult-to-machine designs, closer tolerances, larger contoured parts, new and harder metals. ▼▼▼

Continued on page 34

'VSG' *Infinitely* VARIABLE SPEED GEARS

Regd Trade Mark

'VSG' HYDRAULIC TRANSMISSION GEARS

No. 1 PAPER MACHINE

Papeteries de Roquefort

When the French Company, Papeteries de Roquefort, completely rebuilt the No. 1 Paper Making Machine at their Roquefort (Landes) Paper Mill, 'VSG' hydraulic transmission gears were installed on each of the 11 sections of this machine.

PUSH BUTTON CONTROL

Remote push button stations control the speed of the machine as a whole and provide individual speed trimming at each section.

Full details of this application of 'VSG' drives will be sent on request

VICKERS-ARMSTRONGS (ENGINEERS) LTD

VICKERS HOUSE · BROADWAY · LONDON · ENGLAND Cables: Vickerseng, London Telex

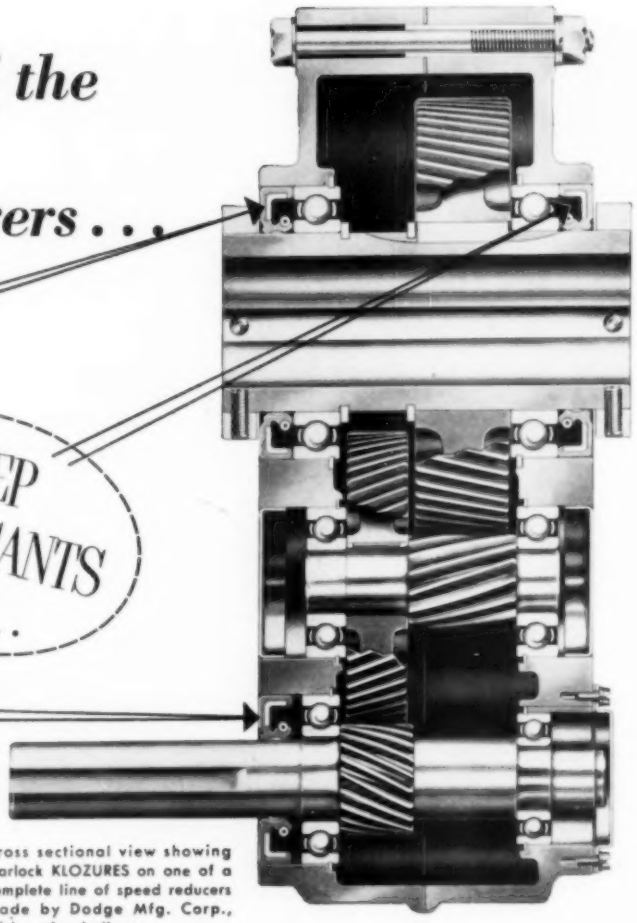
East: Consolidated Engines & Machinery Co. Ltd., 5645, Pare, Montreal, Quebec. **West:** Galbraith & Sulley Ltd., 1331 W. 6th Ave., Vancouver, 9

Over half the speed reducer manufacturers . . .

KEEP DIRT OUT . . .

KEEP LUBRICANTS IN . . .

WITH **KLOZURE*** **Oil Seals**



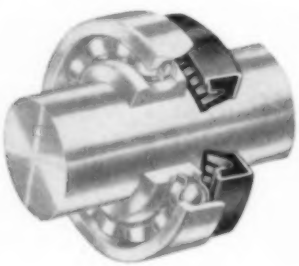
Cross sectional view showing Garlock KLOZURES on one of a complete line of speed reducers made by Dodge Mfg. Corp., Mishawaka, Indiana.

Makers of such fine precision products as The Dodge Torque-Arm Speed Reducer will not compromise when specifying oil seals. They know that the reputation of their entire product may depend on the quality of the oil seals they put in it.

Think about this the next time you have occasion to specify oil seals, and we think you'll choose Garlock KLOZURE Oil Seals—guaranteed to do the job you specify with minimum power loss and heat generation.

KLOZURES are available in a complete range of types and sizes. Therefore, be sure to call in one of Garlock's 125 trained sales engineers right at the start. His experience will save you time and money. Or, write today for Catalog No. 10.

**Registered Trademark*



Model 53 finger spring KLOZURE for normal and high speed service, applied to a shaft to protect the ball bearing.

THE GARLOCK PACKING COMPANY, Palmyra, New York

For Prompt Service, contact one of the 30 sales offices and warehouses throughout the U.S. and Canada.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints

LONGER SOLENOID LIFE...

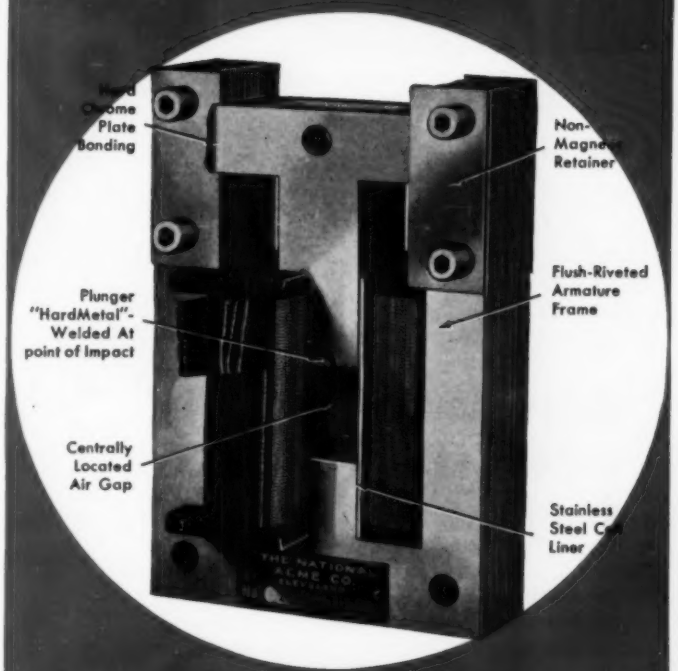
with NAMCO'S exclusive "HARDMETAL"-welded plunger bonding

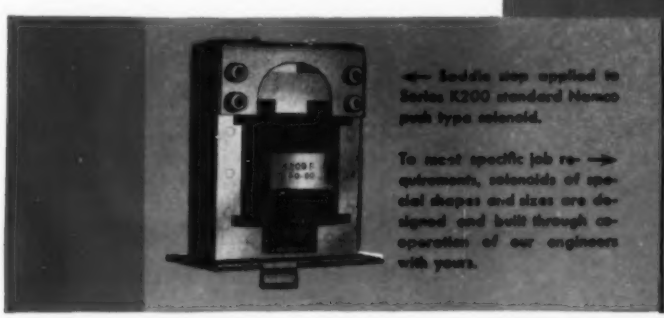
Standard or Custom Models To Fit Your Design

"HardMetal"-welded plunger bonding prevents mushrooming at the vital point of impact—withstands incessant pounding of the plunger on the frame. Long plunger life, and thus long solenoid life, is further insured by hard chrome plating upper guide edges of plunger laminations to reduce friction and wear.

Namco standard solenoids are available in six series of pull and push types; custom-engineered solenoids in every size and type can be made to meet your specifications.

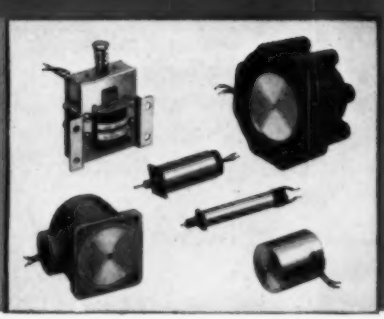
Standard "HardMetal"-Welded Solenoids are furnished push or pull type in sizes with ratings from 2-1/2 to 21 pounds at 1/2" stroke and from 2 to 25 pounds at 1" stroke.





← Saddle step applied to Series K200 standard Namco push type solenoid.

To meet specific job requirements, solenoids of special shapes and sizes are designed and built through cooperation of our engineers with yours. →



Ask us to send a National Acme Representative to discuss your problems, or if you want more information first—send for BULLETIN EM-52.

ELECTRICAL MANUFACTURING DIVISION

National Acme

THE NATIONAL ACME COMPANY • 186 EAST 131ST STREET • CLEVELAND 8, OHIO

BELMONT "Compressor"

stays flexible under intense dry heat

Here is an Air Compressor rod packing designed to thrive on gruelling service.

Belmont "Compressor" No. 760 asbestos packing is lubricated strand by strand, braid by braid, layer by layer to retain its flexibility and good sealing qualities for life—while protecting compressor rods from premature wear.

Another leader in the Belmont Line of "Custom-made for the Service" packings.

Use it for longer life, fewer maintenance jobs.

Ask your U. S. Gasket—Belmont Packing Distributor or write for catalog.

The Belmont Packing & Rubber Co.
Butler & Sepviva Streets
Philadelphia 37, Pennsylvania

U.S. GASKET • BELMONT PACKING

Air-Filled Donuts Make Emergency Device

If you must make an emergency landing on river, lake or on tree tops, be sure you fly a helicopter fitted with donut-type flotation gear.

This CAA-approved emergency pneumatic system, produced by Walter Kidde & Co., Inc., is powered by 3000 psi compressed air stored in a 900 cubic inch fiberglass sphere.

One Inflatair unit is at each wheel. Compressed air is discharged from perforations in ring. Transparent dome protects unit.

Operation of this device is simple. A solenoid-operated valve, actuated electrically by the pilot, permits compressed air to flow through four pneumatic lines each leading to a wheel. At each wheel the compressed air is discharged from perforations in a ring-shaped element into a 3 inch Inflatair. The design of the Inflatair causes the compressed air to force free air into the float in sufficient volume to inflate fully all four rubberized nylon fabric floats at an

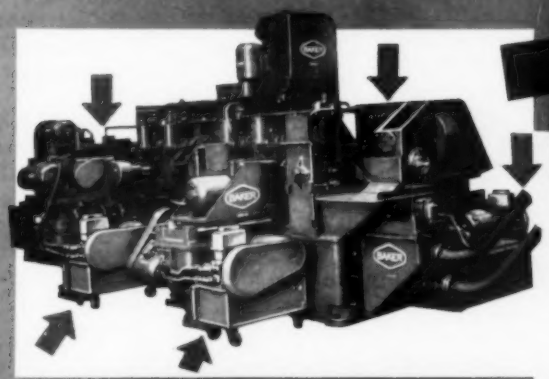
Continued on page 36

Circle 149 on Reader Service Card

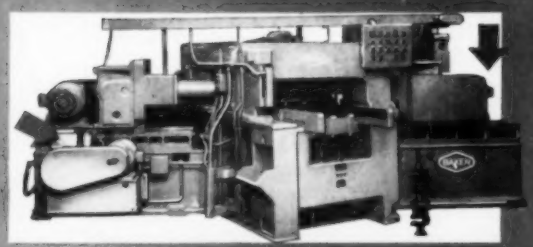
Circle 107

OILGEAR "JK" FLUID POWER FEED PUMPS

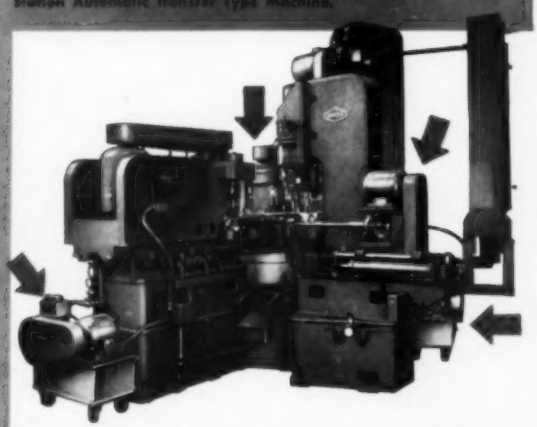
AS APPLIED TO BAKER BROTHERS MACHINES



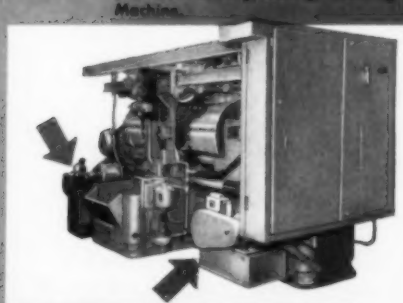
Five Oilgear "JK" Feed Pumps on Baker's Multiple Station Automatic Transfer Type Machine.



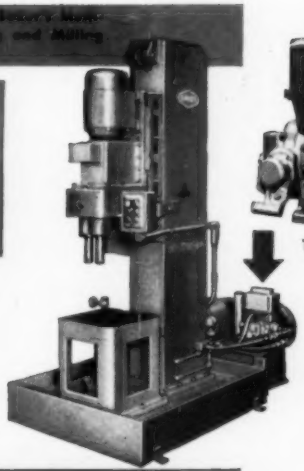
Two Oilgear "JK" Feed Pumps on Baker's Four-Station Automatic Transfer Type Machine.



Four Oilgear "JK" Feed Pumps on Baker's Multiple Head Drilling, Boring, Reaming and Milling Machine.



Two Oilgear "JK" Feed Pumps on Baker's Double End Drilling, Boring and Reaming Machine.



Oilgear "JK" Feed Pump on Baker's Double Spindle Vertical Drilling, Boring and Reaming Machine.

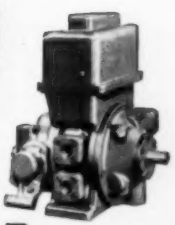
HOW CAN YOU USE THESE SIMPLE, VERSATILE, EASILY APPLIED, PROFITABLE UNITS?

Baker Brothers, Inc., pioneers in machine building, users of Oilgear Feed Pumps since 1925, employ Oilgear "JK" Fluid Power Variable Delivery Feed Pumps on a host of machines including the headline-making 100-foot-long transfer machine and their own commercially available portable hydraulic power unit which you can see in photos Nos. 1 and 3 on this page.

The Oilgear "JK" Feed Pump offers many advantages, not the least of which are easy applicability and accessibility. There's no need in many cases for machine redesign and engineering. And this unit does so much to speed cycle time—traverse speed for example can be 265 times feed rate—that production rises dramatically and costs subside. Both coarse and fine feed rates can be varied infinitely so you at once discover the best rates for your work—and the automatic built-in compensator holds the selected fine feed *unvaryingly*. All functions are controlled automatically, semi-automatically or manually.

Evidence of Oilgear "JK" dependability is growing. In one large automotive plant, now 75% changed over to Oilgear, hydraulic maintenance staff was cut from 6 men to one man per shift. In another great automotive plant, the records show Oilgear is found to give the finest service of all.

There's much more to tell especially about two new units added to the "JK" line. Why don't you send for free literature that gives all the facts and figures. So you won't forget, send for it now.



Type "JK" Pump Built in four sizes.

THE OILGEAR COMPANY
1564 W. PIERCE STREET
MILWAUKEE 4, WIS.

OILGEAR
Fluid Power

PIONEERS . . . NOW THREE PLANTS FOR FLUID POWER

PUMPS, MOTORS, TRANSMISSIONS, CYLINDERS AND VALVES

an ACCO product

Helicoid Gages

How HELICOID GAGES can save YOU money!

LONG LIFE:

HELICOID Gages are pressure instruments of extreme precision and long, trouble-free service with minimum maintenance. Have no gear teeth to wear out.

SUSTAINED ACCURACY:

HELICOID Gages have many unique and exclusive features which result in the highest degree of gage accuracy. Tubes, for instance, will withstand hundreds of thousands of pressure pulsations and will not stretch, leak or crack.

JOB-DESIGNED:

HELICOID Bourdon tubes are made from seamless tubing of alloy steel, K Monel, stainless steel or phosphor bronze. Each is designed to give best service under specific conditions. Available in complete line of cases for wall or stem mounting.

Acaloy square flush case

Helicoid Chemical gage

Send for catalog

ACCO

Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-H Connecticut Avenue • Bridgeport 2, Connecticut

for Better Value

BRIEFS continued

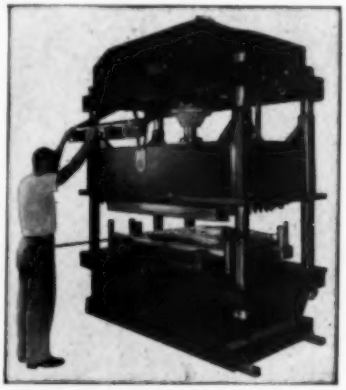
average internal pressure of 1¼ psi. Full inflation takes only four to five seconds. After use they can be deflated and refolded for further use.

For areas with extreme temperature variations, the equipment has topping equalizers to bleed off or add air as required. Self-regulated, they prohibit over-pressured or under-pressured floats. This complete pneumatic system weighs less than 50 pounds, and 170 pounds with the floats.

Happy landings! ▼▼▼

Hydraulic Presses Speed Up Plastics Trimming Operations

Five standard models of hydraulic presses, in capacities from 75 to 300 tons are now available for trimming and piercing parts



made from vacuum formed plastic.

These presses, built by Dake Corporation, Grand Haven, Mich., feature fast ram approach for time-saving closure and return of the movable platen, adjustable stroke control for automatic slowdown before work is connected, and accurate pressure for maximum job flexibility. ▼▼▼

Aircraft Fatigue And Jet Noise . . .

. . . will be discussed among the subjects offered in a two week Special Summer Program, June 18-29, at Massachusetts Institute

Continued on page 38

Circle 65 on Reader Service Card

Circle 162 ⟶

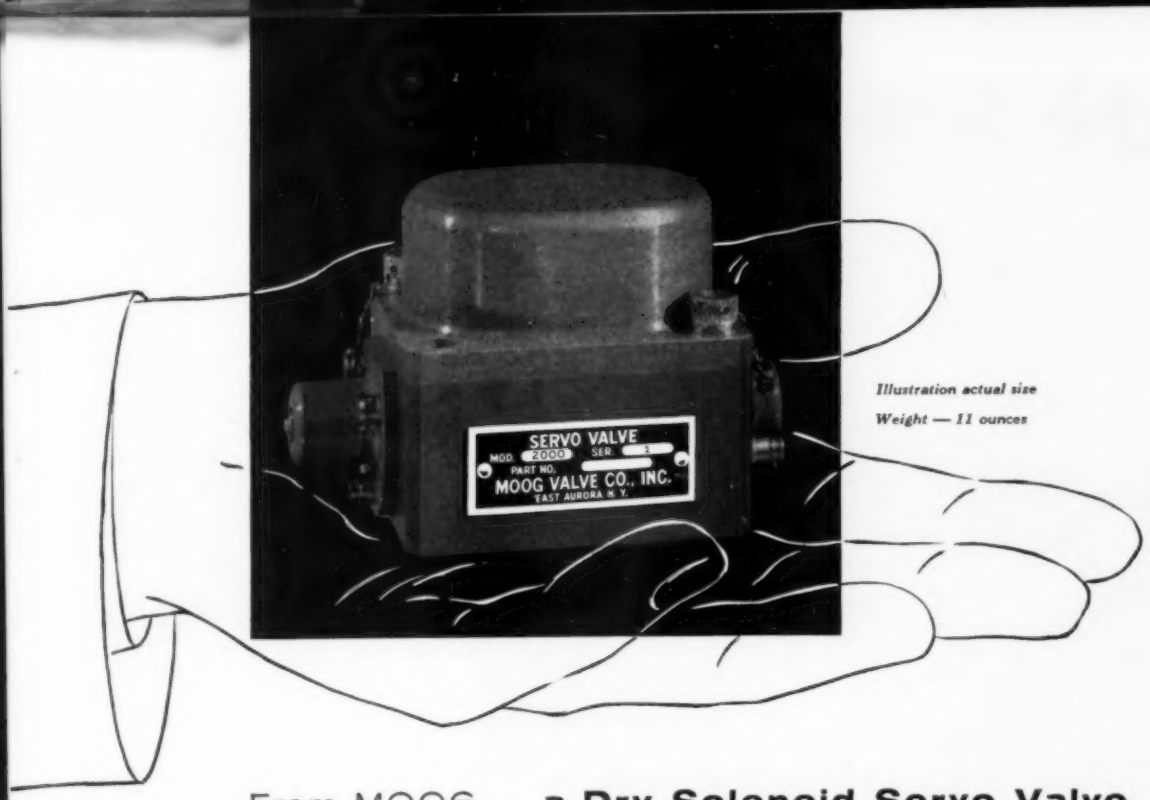


Illustration actual size

Weight — 11 ounces

From MOOG . . . **a Dry Solenoid Servo Valve**

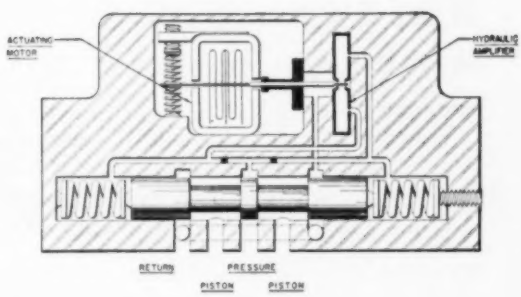
For those electro-hydraulic servo systems which require valves of high dynamic performance, reliability, small size and low weight, Moog units have achieved recognition as the industry standard.

And now, for those systems in which the fluid contains entrained iron, Moog has developed the Model 2000 Servo Valve. These units feature a dry solenoid which eliminates the possibility of torque motor contamination due to magnetic particles. These valves comply with requirements of MIL-H-5440A and are smaller and lighter than other Moog units of the same flow capacity.

Moog Valves, including Model 2000, are proportional type, electrically actuated, hydraulic, four-way valves featuring high dynamic response, sensitivity, linearity, and reliability. Production models are designed to operate in hydraulic systems of from 1000 to 3000 psi pressure. Rated output flows from 0.1 to 50.0 GPM for control currents of from 2.0 to 40.0 milliamperes as specified are available in production units.

Conventionally the valve input is from a balanced push-pull DC amplifier and the valve flow output is applied to a piston or hydraulic motor. An electric signal proportional to piston position or motor angular rotation is fed back to the amplifier to give a closed servo loop.

Typical applications for these units are in servo systems used for guided missile and aircraft flight controls, radar scanner actuation, contour following machine tools, and automatic packaging equipment.



For details write for Bulletin 2000-3

MOOG VALVE CO., INC. PRONER AIRPORT EAST AURORA, N. Y.

R/M VEE-FLEX®

is America's most copied packing...

BECAUSE **it is designed for practically every piston and rod**

BECAUSE **it can be supplied with rock-hard adaptor rings**

BECAUSE **it has polymer-saturated fabric**

BECAUSE **it has precision trimming**

BECAUSE **it has proper interference for automatic sealing**

No matter what your hydraulic application, you will get better sealing with R.M Vee-Flex. The background of this packing is top-flight design engineering combined with superior molding techniques. The result is a self-sealing, self-adjusting packing that will always give you a perfect seal—even at pressures in excess of 6000 psi.

R/M MAKES A COMPLETE LINE OF MECHANICAL PACKINGS

R/M's line of molded hydraulic and pneumatic packings includes:

VEE-FLEX PACKINGS
VEE-SQUARE PACKINGS
HOMOGENEOUS VEE-RINGS
FABRIC PISTON CUPS

For complete information, send for booklet

R/M PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

FACTORIES: Bridgeport, Conn.; Manheim, Pa.; Passaic, N.J.; Neenah, Wis.; No. Charleston, S.C.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Packings • Asbestos Textiles • Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Laundry Pads and Covers • Bowling Balls

BRIEFS continued

of Technology, under the title "Vibration, Shock and Noise".

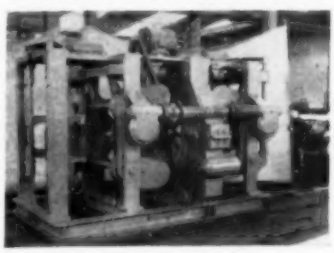
The program will provide a survey of recent advances in these fields, particularly for mechanical engineers engaged in design or development work. Lectures will be supplemented by demonstrations and visits to MIT laboratories.

Full details may be obtained from the Summer Session Office, Room 7-103, Massachusetts Institute of Technology, Cambridge 39, Mass. ▼▼▼

Pneumatically Operated Debarker Eliminates Wood Losses

Air power has been successfully applied to a debarking machine built by Sonderhamn Machine Manufacturing Co. It handles softwood and irregularities common to hardwood.

Four horizontal feed rolls and four vertical guide rolls are pneumatically operated. These are synchronized for opening and closing



and are separately controlled. The debarking chamber consists of a housing with six rolls supporting a rotor where the radially movable stellite tipped tools are located. Six to twelve tools and their actuating pneumatic pistons are located around the inner circumference.

A stationary distribution chamber transmits the air into the cylinders forcing all tools to be extended simultaneously and with equal pressure. Sufficient pressure is supplied against the pistons to prevent the tools from riding over the bark, but it is not great enough to penetrate into the wood. ▼▼▼

Continued on page 42

? ?

6 sizes in 2

Rivett Model 6655 Solenoid Controlled, Pilot Operated, Panel Mounted, Hydraulic Valve.

of course!

Rivett Panel Valves
feature interchangeable sizes

By changing pipe tap size in steel subplate, the 1″ basic valve may be used for either ⅜″, ½″, ¾″, or 1″ I.P.S.; and the 1½″ basic valve for 1¼″ and 1½″.

CORRECT SIZE IS ALWAYS AVAILABLE

and here's another important feature!

GREATER FLOW CAPACITY

Flow capacities are rated at a higher G.P.M. at less velocity per ft. per sec. For example: the 1″ size is rated at 28 G.P.M. at 15 ft. per sec.

12 other good reasons tell why Rivett Hydraulic Solenoid Panel Valves are your best buy! Get the facts in this new catalog. Write today!

RIVETT LATHE & GRINDER, INC.
Dept. AH-5, Brighton 35, Boston, Mass.

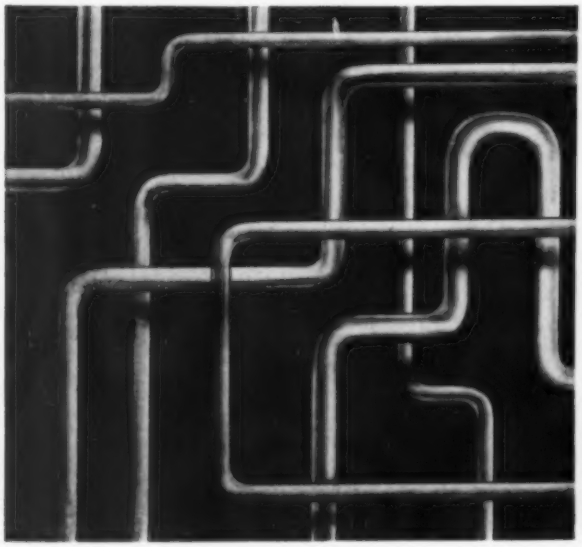
The Better You Know Hydraulics—
The Better You Like

RIVETT furnishes a complete power package

AIR AND HYDRAULIC — VALVES, CYLINDERS, POWER UNITS

Member—National Fluid Power Association

Eliminate Costly Hydraulic Failures with



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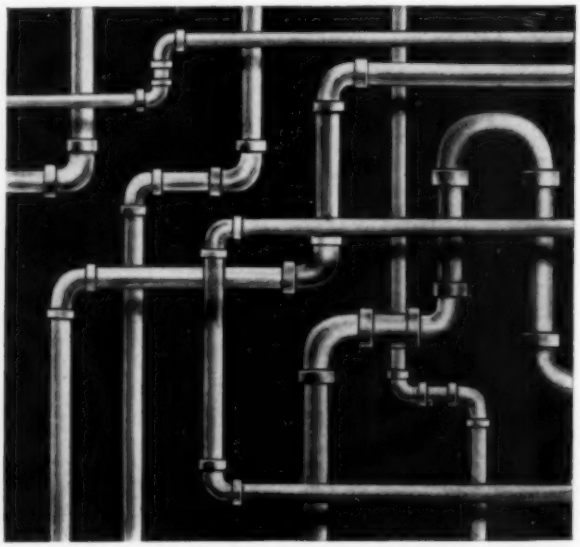


NOT THIS

Today's hydraulic and design engineers know that tubing is the modern, efficient method of handling fluids. It saves space and weight. It offers tighter joints, greater strength, and less pressure drop. It is easily bent and flared. Less fittings are required. Installation costs and time are lower.

Superior specializes in producing seamless low-carbon steel hydraulic tubing that is closer on critical features than the SAE specifications. The table below lists recommended maximum working pressures (psi) for hydraulic tubing. Sizes for which pressure limits are printed inside block at lower right are beyond Superior's production limits. These larger sizes are also available, however, from Superior distributor warehouse stocks.

Maximum Working Pressures (psi) Recommended for Hydraulic Tubing

WALL OD	.025"	.028"	.032"	.035"	.042"	.049"	.058"	.065"	.072"	.083"	.095"	.109"	.125"
1/8"	6000	6700	7680	8430	9920	11750	x	x	x	x	x	x	x
5/32"	4000	4470	5100	5610	6750	7850	x	x	x	x	x	x	x
1/4"	2980	3350	3830	4200	5040	5890	7000	7850	x	x	x	x	x
5/16"	2410	2690	3080	3370	4040	4710	5610	6290	6950	8010	x	x	x
3/8"	1990	2240	2560	2800	3360	3920	4660	5240	5790	6660	7640	8720	9990
13/32"	1845	2070	2360	2585	3100	3620	4285	4800	5320	6130	7015	8050	9235
7/16"	1715	1920	2190	2400	2880	3360	4000	4500	4960	5720	6550	7490	8580
1/2"	1490	1675	1920	2100	2520	2940	3500	3925	4340	5000	5720	6540	7500
9/16"	1330	1490	1705	1870	2240	2620	3110	3490	3860	4450	5090	5810	6660
5/8"	1200	1340	1535	1680	2020	2350	2800	3140	3470	4000	4580	5230	6000
11/16"	1090	1220	1395	1530	1830	2135	2530	2835	3140	3620	4145	4755	5455
3/4"	1000	1120	1280	1400	1640	1960	2320	2600	2880	3320	3800	4360	5000
7/8"	860	960	1090	1200	1440	1680	1985	2225	2465	2845	3255	3740	4285
1"	750	840	960	1050	1260	1470	1740	1950	2160	2490	2850	3270	3750
1 1/8"	665	747	854	935	1120	1310	1545	1735	1920	2215	2535	2910	3330

Note: The values above are based on an allowable fibre stress of 15,000 psi. For approximate bursting pressures, multiply these values by a factor of 3.3. The formula used for calculating the above pressures is Barlow's:

$$P = \frac{2St}{OD}$$

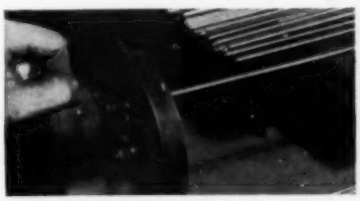
where S = fibre stress in psi, t = wall thickness in inches, OD = Outside diameter in inches

Premium Superior SAE Hydraulic Steel Tubing

5 IMPORTANT REASONS WHY SUPERIOR SAE HYDRAULIC TUBING IS YOUR BEST CHOICE

1. *It contains 0.12% maximum safe carbon content for high ductility—permits easy hand bending and flaring*
2. *It is manufactured from special non-aging steel that prevents loss of ductility and impact resistance during storage and/or use*
3. *It is hydrostatically tested at maximum working pressures*
4. *Its clean, smooth inside surface minimizes pressure drop due to back pressure and internal friction*
5. *Installed with proper tube fittings, it is dependable and leakproof*

RAW MATERIAL undergoing boroscopic examination, part of Superior's quality control program.



TUBING MUST FLARE without difficulty and without forming minute surface notches or breaks.

EVERY SINGLE LENGTH of Superior (SAE) Hydraulic Tubing is 100% hydrostatic tested.

But Superior hydraulic tubing offers you many more big advantages. It is produced under rigid quality controls that begin with general inspection and boroscopic examination of raw stock. Tubing is mandrel drawn to hold the ID to commercial tolerances or better. Bright annealing and degreasing produce clean, scale-free tubing. The ends, outside and in, are deburred. Each order is inspected for flareability by a careful sampling method and 100% hydrostatically tested. It is then oil-dipped for rust prevention. At the customer's request, tubing can also be capped or corked to keep ID surfaces clean. It is then carefully wrapped in waterproof paper and boxed for shipment. Tubing is furnished in dead soft-annealed temper for ease in bending and is available in cut, multiple or random lengths up to 30 feet or longer in coiled form.

Below are just a few of the many applications for Superior low carbon steel SAE hydraulic tubing. They may suggest other practical uses to you.

Hydraulic lines on machine tools, extension presses, welding machines and control panels • Oil and fuel lines on aircraft engines • Agricultural equipment control lines • Refrigerator generator pump lines • Parts of machinery for glass forming and bottle blowing • Diesel locomotive lubrication lines • Heating coils for oil and asphalt kettles • Vaporizing coils for oil burners and torches • Service station lubrication equipment • Materials handling equipment • Construction equipment

If you have hydraulic tubing problems, let Superior's tubemanship and years of industry-wide experience help solve them. Write Superior Tube Company, 2030 Germantown Ave., Norristown, Pa., for Bulletin No. 39, giving additional technical data on hydraulic tubing.

SUPERIOR LOW-CARBON STEEL SAE HYDRAULIC TUBING IS AVAILABLE IN MANY SIZES IN SUPERIOR DISTRIBUTOR WAREHOUSES FROM COAST TO COAST

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses available in .010 in. to ⅜ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif.

National offers you

Top quality O-Rings, dependably uniform, delivered on time!

Here's the way National insures uniform high quality in National O-Rings:

All ingredients are of highest quality, carefully inspected before compounding. Compounding is done under strict controls to insure absolute uniformity of batches. Molding is done on modern equipment by skilled veterans in O-Ring manufacture. Rings are given a complete precision trim, then complete inspection. Every precaution is taken to insure that no O-Rings with cuts, scratches or mold defects are shipped.

A complete line of industrial O-Rings, including the new small cross-section rings, is available for prompt shipment from convenient warehouses. Prices are most competitive. Call the nearest National Applications Engineer and prove this to yourself!

NATIONAL
OIL & GREASE SEALS
O-RINGS SHIMS

NATIONAL MOTOR BEARING CO., INC.

GENERAL OFFICES: REDWOOD CITY, CALIFORNIA
PLANTS: REDWOOD CITY AND DOWNEY, CALIFORNIA; VAN WERT, OHIO

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DALLAS, TEXAS .....2520 *West Mockingbird Lane, DIxon* 7541
DETROIT, MICH. .....13836 *Puritan Avenue, VErmont* 6-1909
DOWNEY (Los Angeles Co.), CAL., 11634 *Patton Rd., TOpaz* 2-8163
INDIANAPOLIS, INDIANA .2802 *North Delaware St., WAlnut* 3-1535
KANSAS CITY, MO. .....4445 *Terrace, LOgan* 6622
MILWAUKEE, WIS. ....647 *West Virginia Street, BRoadway* 1-3234
NEWARK, N. J. .....1180 *Raymond Blvd., MItchell* 2-7586
REDWOOD CITY, CALIF. . *Broadway and National, EMerson* 6-3861
WICHITA, KANSAS .....519 *South Broadway, AMherst* 2-6971

BRIEFS / continued

Air Power Increases Household Products Fabrication

Shop-built devices, making use of air power, have helped to solve production problems in the manufacture of shower doors and storm windows.

Keystone Shower Door Company uses two air cylinders to press

Figure 1

Figure 2

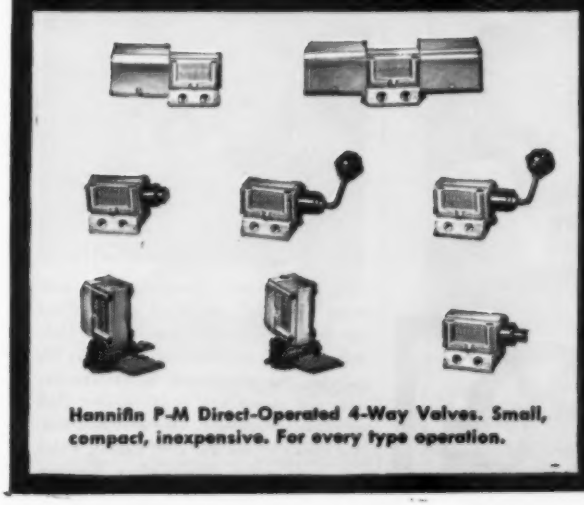
metal strips into the side of the shower doors—Figure 1. This operation was previously done manually with the aid of a hammer, tapping the strips into position. This often resulted in damaged doors. Apart from eliminating this costly damage, these air cylinders also provide uniform pressure. Figure 2 shows a simple device, using two air cylinders, which was installed by the All-Lite Aluminum Co., to bend frames for storm windows. ▼▼▼

Continued on page 44

The Fourth Annual
APPLIED HYDRAULICS
Prize Paper Contest
Closes on July 1, 1956.

Hannifin Disc Valves. 3-way and 4-way, direct- or pilot-operated. For hand, foot or electric actuation.

Hannifin P-M Master Valves. 2-way, 3-way, 4-way. Remotely controlled from wide choice of Pilot Valves.



Hannifin P-M Direct-Operated 4-Way Valves. Small, compact, inexpensive. For every type operation.

Hannifin P-M Pilot-Master Valves. Solenoid controlled by integral pilot heads. 2-way, 3-way and 4-way.

HANNIFIN has the Air Control Valves for Your Specific Applications

Hannifin has the air control valves you need for use on your production lines or on the products you manufacture, often in a choice of types.

Shown here are typical valves from the extensive and complete Hannifin line. There's a Hannifin valve for every use from the simplest to the most complicated air-operated circuit. Singly or in combination, Hannifin valves provide hand, foot, cam, pressure or solenoid operation...in almost every pipe size.

You can simplify your air control valve problems by standardizing on Hannifin. Why not discuss your requirements with your Hannifin Field Engineer?

HANNIFIN

STOCK DELIVERY ON ALL HANNIFIN VALVES — MAIL THE COUPON

☐ Have Field Engineer call at once

☐ Have Field Engineer stop by soon

☐ For the present, just send complete Hannifin Control Valves Catalog

Hannifin Corporation, 545 S. Wolf Rd., Des Plaines, Ill.

Name.....*Title*.....

Company.....

Address.....

City.....*Zone*.....*State*.....

Circle 62 on Reader Service Card

IF
"THE PRINCIPLE OF THE THING"
MEANS ANYTHING TO YOU
then look to ROPER

only 2 moving parts
HELP MAKE ROPERS DEPENDABLE

SMOOTH AND QUIET FLOW...
EQUAL EFFICIENCY IN EITHER DIRECTION

HOW IT OPERATES — The unmeshing of the gears produces a vacuum, drawing the liquid into the tooth spaces. The liquid is carried between the teeth and case to the opposite side of the pump. The meshing of the gears forces the liquid into the discharge line. This is a positive displacement pump. The Roper principle is simple in design. It has only two moving parts — equal size pumping gears — operating in a case with proper amount of clearance to promote high efficiency and long life.

GEO. D. ROPER CORPORATION 705 Blackhawk Park Ave., Rockford, Ill.

DESIGN ENGINEERING SHOW
CONVENTION HALL PHILADELPHIA
MAY 14 to 17, 1956

BOOTH 426

ROPER Rotary Pumps

BRIEFS / continued

Fire-Resistant Fluid For U.S. Navy

Hydraulic systems of deck-edge elevators on U.S. Navy aircraft carriers will use a new fire-resistant fluid manufactured by the Chemical Division of the Celanese Corporation of America. Designated Cellulube 220, this new fluid is a straight chemical synthetic oil, which minimizes fire and explosion hazards. ▼▼▼

A hydraulically powered system provides fingertip control of all functions for this loading attachment for a Link-Belt Speeder shovel-crane. Known as Excaloder, the attachment is interchangeable with shovel, hoe, dragline, clam shell or crane attachment. Operator can control speed of the dumping bucket, which will close automatically when dumping lever is released, or can be retained in open position for grading by toggling control lever in fully open position. ▼▼▼

Recent Publications

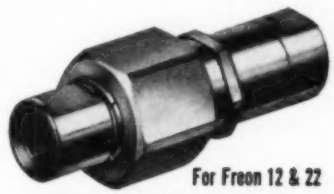
Purchase Law Manual. By Albert Woodruff Gray, published by Book Division Conover-Mast Publications, Inc. 390 pp.

This volume was specially written for the purchasing agent, giving him specialized information about the law which affects a purchaser's relationship with his suppliers. Features incorporated into this manual make it easy and quick to use. It is divided into 56 chapters. Each chapter indicates at the beginning in bold-face type the key points dealing with that particular phase of purchase law. Special attention has been devoted to the index to make it as complete and helpful for quick reference.

Continued on page 46

Fluid Systems That Need Frequent Disconnection

NEED AEROQUIP SELF-SEALING COUPLINGS

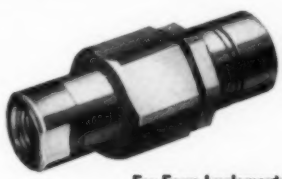


For Freon 12 & 22

Aeroquip 511017 Self-Sealing Coupling for refrigeration and air-conditioning applications makes low cost field installation possible by permitting factory charging of the units and lines of various lengths. Mates with sweat-type adapters.

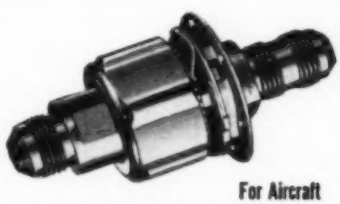
For LP Gas

Aeroquip 5102 Self-Sealing Coupling speeds recharge of LP-Gas fuel tanks on trucks, tractors. Coupling has Acme and P.O.L. threads to fit any recharge line. Absolutely no leakage of fuel upon connecting or disconnecting.



For Farm Implements

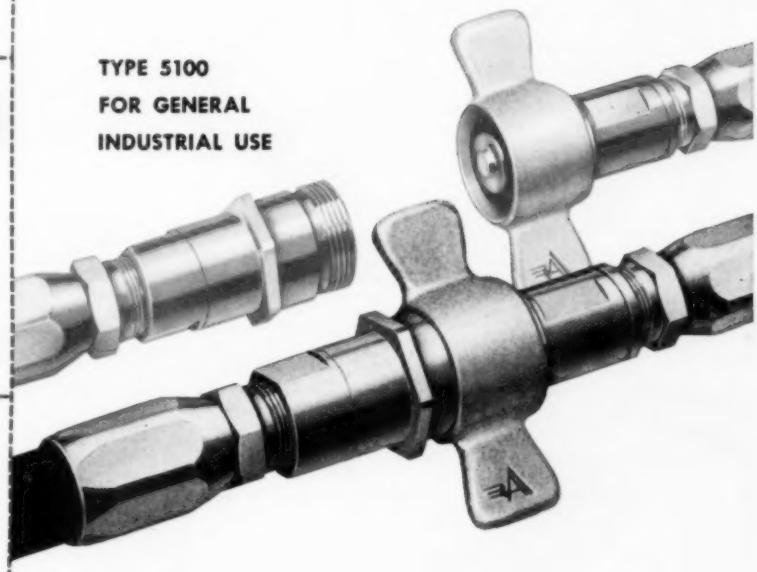
Aeroquip 5203 Self-Sealing Coupling provides quick, easy interchange of hydraulic trailing and tractor-mounted equipment. Mates with the Aeroquip Breakaway.



For Aircraft

Aeroquip 155 & 145 Self-Sealing Couplings speed inspection, servicing or replacement of engines and other aircraft fluid system components. Ideal for engine test stands.

TYPE 5100
FOR GENERAL
INDUSTRIAL USE



Aeroquip Self-Sealing Couplings permit quick connection and disconnection of fluid lines under pressure, without loss of fluid or inclusion of air into the system.

Type 5100 coupling has a wide range of industrial uses on air, water, hydraulic, fuel and lube oil lines. It is ideal for stationary and mobile equipment where fluid-carrying lines must be disconnected and reconnected frequently for servicing, moving, or interchanging of parts and accessories.

CATALOG No. 200 contains complete information on Aeroquip Self-Sealing Couplings and flexible hose lines with reusable fittings, plus valuable fluid line data. Write for your copy.

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

IN CANADA: AEROQUIP (CANADA) LTD., TORONTO 15, ONTARIO

LOCAL REPRESENTATIVES IN PRINCIPAL CITIES IN U.S.A. AND ABROAD • AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

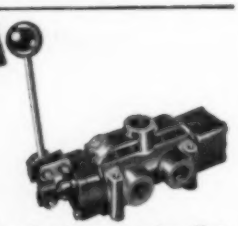
ADEL *Industrial Hydraulic Equipment*

for PEAK PERFORMANCE ADEL Hydraulic Valves and Pumps are setting new and ever higher standards for precision in manufacturing and efficient performance in operation. Following are but a few of the wide variety of models to meet all operating conditions.

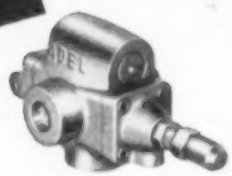
GEAR-TYPE HYDRAULIC PUMPS

For 1000 psi service with rated capacities at 1800 rpm of from 1.5 to 46.8 gpm.

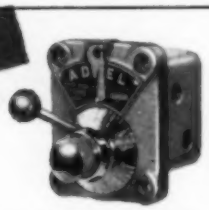
DIRECTIONAL CONTROL VALVES



4-way valves with spring-centered, spring-offset, and 1, 2, or 3 position detent action. 1500 psi. Flows to 28 gpm.

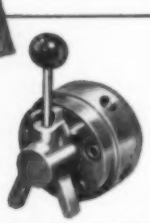


Relief, Sequence and Unloading valves. Direct or remote operation, 50 to 1500 psi range.



Compensated type maintains constant flow over wide differential pressure range. No drain line required. 1500 psi.

PILOT VALVES



2 or 3 position detent. With or without dog or lever. Can be used as 4-way valve in small circuits. 1000 psi.

CHECK VALVES

Valves allow free flow in one direction only. Many variations available. 3000 psi.

For complete engineering specifications and counsel, Address: ADEL PRECISION PRODUCTS, DIVISION OF GENERAL METALS CORPORATION, 10771 Van Owen Street, Burbank, California.

ADEL PRECISION PRODUCTS
A DIVISION OF GENERAL METALS CORPORATION

Manufacturers of Industrial Hydraulic Valves and Pumps

DISTRIBUTORS: AIR-DRAULIC EQUIPMENT CO., HOUSTON, TEX. • AIR & HYDRAULIC ENGINEERING CO., NEW HAVEN, CONN. • RUSS CHAMBERLIN COMPANY, PORTLAND 14, ORE. J. BOYD COATES, GLENSIDE, PA. • CORBY SUPPLY COMPANY, ST. LOUIS, MO. • FRANK T. DONNELLY COMPANY, PITTSBURGH 38, PA. • HASKEL ENGINEERING & SUPPLY CO., GLENDALE 4, CALIF. • HASKEL ENGINEERING & SUPPLY CO., SAN FRANCISCO 7, CALIF. • AIR-DRAULICS COMPANY, PHOENIX, ARIZ. • INDUSTRIAL AIR & HYDRAULIC EQUIP. CO., DETROIT 15, MICH. LINCOLN SUPPLY COMPANY, PROVIDENCE, R. I. • L. H. MONSEES, INDEPENDENCE, MO. • THE NEFF ENGINEERING CO., FORT WAYNE 3, IND. • POWER DRIVES, INCORPORATED, BUFFALO, N. Y. • SCOTT EQUIPMENT & ENGINEERING CO., DAYTON 10, OHIO • ROBERT TAYLOR & SONS, SALT LAKE CITY 10, UTAH • WYATT SALES COMPANY, CLEVELAND 15, OHIO TRI-STATE SUPPLY COMPANY, BROOKLYN 33, N. Y.

BRIEFS continued

ASME Handbook: Engineering Tables: Edited by Jesse Huckert. Published by McGraw-Hill. 704 pages. Price $12.00.

Engineering Tables is one of the four volumes comprising the ASME handbook, sponsored by the Metals Engineering Handbook Board of the ASME. The volume is conveniently arranged in 15 sections, grouping together tables which apply to the design of specific parts. It features many tables of recognized design standards of the type not commonly found in handbooks. Design calculations presented will save a lot of the engineer's time.

Other volumes of the handbook are: Metal Properties, Metals Engineering—Design, and Metals Engineering—Processes. ▼▼▼

Future Events

May 14-17: First Design Engineering Show. Convention Hall, Philadelphia, Pa. Machine Design Division of ASME will sponsor design engineering conference to coincide with exposition.

May 27-31: 1956 Spring Meeting, National Fluid Power Association. The Greenbrier, White Sulphur Springs, West Virginia.

June 3-8: SAE Summer Meeting. Chalfonte-Haddon Hall, Atlantic City, New Jersey.

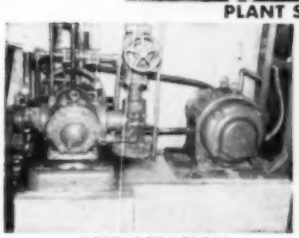
June 5-8: The Material Handling Institute's Exposition of 1956. Public Auditorium, Cleveland, Ohio.

September 17-21: The Instrument Society of America, the 11th Annual Instrument-Automation Conference and Exhibit. New York Coliseum, New York.

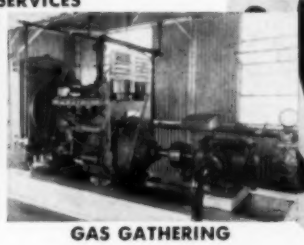
October 18-19: 12th National Conference on Industrial Hydraulics. Sherman Hotel, Chicago, Illinois. Conference Secretary is Raymond D. Meade.

October 30-November 1: 1956 Fall Meeting, National Fluid Powef Association. Hotel Cleveland, Cleveland, Ohio. ▼▼▼

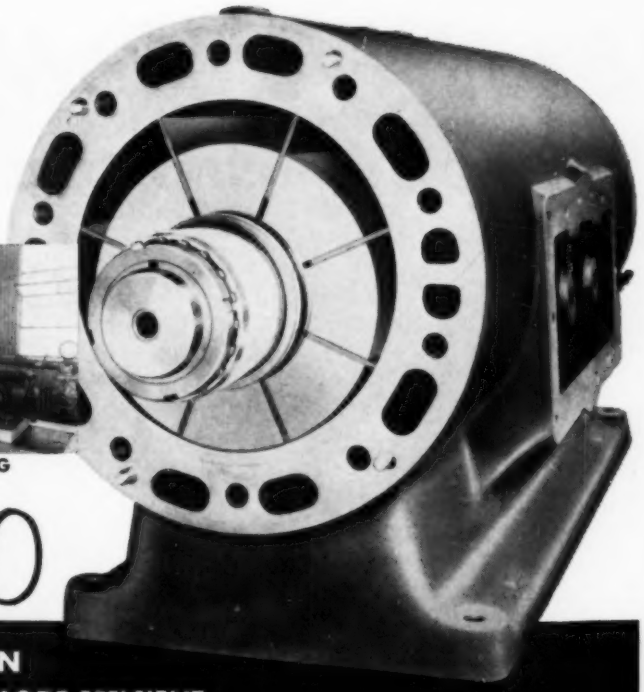
PLANT SERVICES



REFRIGERATION



GAS GATHERING

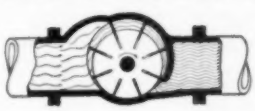


Since 1930

. . . FULLER ROTARY MOTION has been the key to SMOOTHER, MORE EFFICIENT, LOWER COST AIR COMPRESSION

The unique revolving principle pioneered by Fuller is the heart of the Fuller Rotary Compressor—both single- and two-stage types—and provides impressive cost, maintenance and operating advantages.

Simplified Fuller design consists essentially of a rotor eccentrically mounted in a cylinder to form a crescent divided into sections by the rotor blades. Each section or pocket carries air from one end of the crescent to the other without reversal of flow and with measurable improvement in volumetric efficiency. The rotor blades move freely by centrifugal force alone and compensate automatically for wear. As a result, Fuller Rotaries can operate indefinitely without care and the occasional inspection check required can be made with fewer men and in far less time.



Clip, fill in and mail the coupon for detailed information about Fuller Rotary Compressors for plant services, refrigeration or gas gathering.

FULLER COMPANY
142 Bridge St., Catasauqua, Pa.
A SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORP.
Chicago • San Francisco • Los Angeles • Seattle • Kansas City • Birmingham

Fuller
pioneers in harnessing AIR

C-285
9002

COST-SAVING ADVANTAGES

1. Smooth, pulse-free, one-way air flow
2. Almost complete lack of vibration permits use of light foundation
3. Far fewer moving parts insure low maintenance
4. Small size for high capacity permits installation in minimum space
5. Direct drive further reduces space requirements
6. Valveless design permits continuous, unsupervised operation and greatly reduces maintenance

Fuller Rotary Compressors:

- Maintain original capacity for the life of the machine
- Provide a high degree of reliability, thereby reducing standby capacity requirements
- Have few moving parts, thus sharply reducing parts inventory
- Require minimum supervision and inspection

It will pay you to compare Fuller Rotaries with other compressors and evaluate Fuller advantages to your operation in terms of annual net savings. Fuller Rotaries are available for industrial pressures to 125 psig and capacities to 3300 cfm. We will be glad to supply you with facts based on actual experience with Fuller installations over the past 25 years.

FULLER COMPANY
142 Bridge St., Catasauqua, Pa.
Please send me, without obligation, descriptive literature on the Fuller Rotary Compressor. I am specifically interested in a pressure of _____psig and a capacity of _____cfm, to be used for:

NAME_____ ☐ Plant Services
TITLE_____ ☐ Refrigeration
CO. NAME_____ ☐ Gas Gathering
STREET ADDRESS_____
CITY_____ ZONE_____ STATE_____

Built To "Sell"...

your product

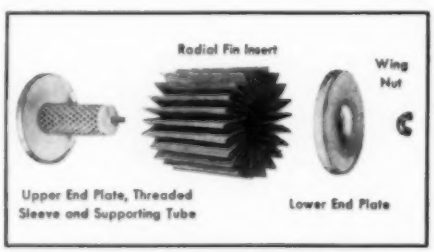
STAYNEW

FILTERS

for Sump pumps and hydraulically operated equipment

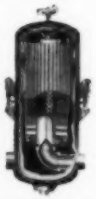
Model HE for use wherever dirty liquids are collected, filtered and re-circulated. Unique Radial Fin design gives largest filtering area in smallest space.

Generally, the cost of a filter is inconsequential . . . compared to the job it does and the total cost of your product. That's why it's poor economics to accept anything but the best filter made. The buyer of your product can tell immediately if you're using a cheap filter; and if you are, he may also wonder about the other components, and you may lose the sale. Don't take the chance, even when you *think* a cheaper filter will do the job. *Quality* is a great silent salesman. Specify Staynew Filters, famous for quality.



Entire unit can be disassembled in 30 seconds for easy cleaning.

INTAKE FILTERS

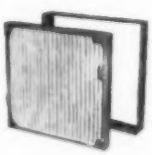


LIQUID FILTERS

PIPE LINE FILTERS

ELECTRO-STAYNEW PRECIPITATOR

AUTOMATIC AIR FILTERS



PANEL FILTERS

SPECIAL FILTERS

DOLLINGER PROTECTO-MOTOR STAYNEW FILTERS

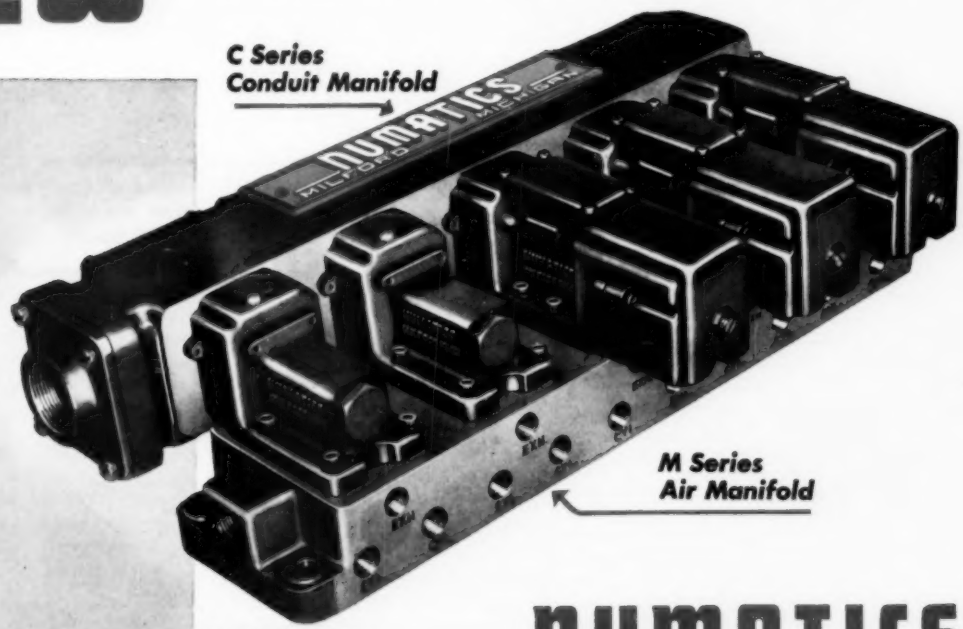
DOLLINGER CORPORATION

ALL TYPES OF FILTERS FOR EVERY INDUSTRIAL NEED

Write for Bulletin 330 which describes Filters for sump pumps and hydraulically operated equipment. Dollinger Corporation, Dept. 65, Centre Park, Rochester 3, N. Y.

LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS
ELECTROSTATIC FILTERS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS
VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS • HIGH PRESSURE FILTERS
AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS

NEW... AIR MANIFOLDS!



...Another FIRST from NUMATICS

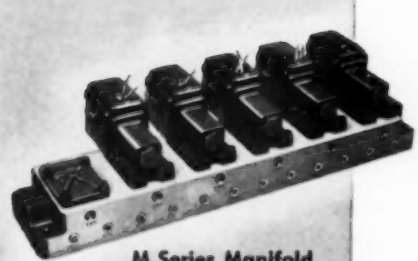
...the new leader in air controls

Here is a completely new approach to the problem of mounting, piping, and wiring solenoid operated air valves. The Numatics SA Series offers an entire group of manifolds, providing all the advantages of custom-engineered mountings in a standard catalog line, a significant forward step in fluid controls engineering.

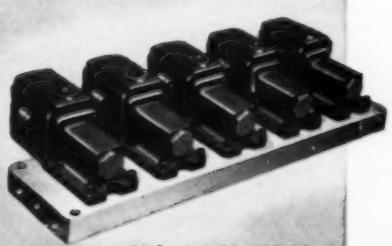
Numatics SA Manifolds save space, simplify piping, improve accessibility, and enhance the appearance of your equipment. All valves in the SA Series, single solenoid spring return, momentary contact, and spring centered, mount interchangeably on any station of the air manifolds. The conduit manifolds eliminate separate electrical pull boxes and conduit runs, can be used with both M Series and H Series air manifolds.

Available for all sizes and models of SA Series valves, in ¼", ⅜", ½", and ¾", pipe sizes, Numatics SA Manifolds are an outstanding development in air controls.

Why not investigate how Numatics SA Series valves and manifolds can improve YOUR equipment. Just call your nearest Numatics representative or write us for Numatics Bulletin 8000.



M Series Manifold
For maximum piping flexibility. Cylinder ports in both sides and bottom, can be piped from any side or combination of sides.



H Series Manifold
Common exhaust manifold, with all exhaust ports manifolded into two exhaust chambers. Allows easy piping or muffling of exhausts. Cylinder ports in bottom face only.

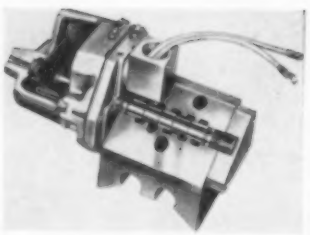
NUMATICS, Inc. DEPT. AH

MILFORD • MICHIGAN

Circle No. 106 on Reader Service Card

New Products

Components, tools and equipment for fluid power systems. For more information fill in and mail post card bound in this issue.



SPOOL TYPE, AIR VALVE

. . . cycles in .033 sec.

Designation: Comet II

Features: Compact, lightweight valve has working surfaces almost diamond hard and is finished to tolerances of .0001 inch.

Specifications: Valve is available with ¼ or ⅜-inch pipe tap for inline, manifold, or base mounting; and is made in single-solenoid, spring-return; double-solenoid, momentary; and double-solenoid, 3-position types. These direct solenoid operated, 4-way, spool types can be used for 2-way or 3-way applications by plugging ports. Flow capacity is equal to a ¼-inch hole and valve measures 7¼ x 3½ x 3⅞ inches.

Ross Operating Valve Co.
Detroit, Michigan

Circle 180 on Reader Service Card

AIR MOTOR

. . . redesigned for greater life

Designation: L20

Design: Oscillating motor is now equipped with Nitralloy rollers instead of high carbon steel to operate the trip valve. Synthetic rubber buffers are fitted in the shuttle valve to reduce hammering, and a silencer is now installed on the exhaust. The modifications extend the life to about 5 years of continuous operation before an overhaul.

Specifications: Air motor develops torque of 400 in.-lb. with air pressure of 80 psi and has a rotation of 180 degrees. It requires 1 cfm of air and has a maximum of 25 double strokes per minute.

Applications: Air motor is used for agitation of paint, chemicals, processed foods and similar applications where fire hazards exist. It is also used for driving light, slow speed conveyors and automatic filters.

Alfred Bullows & Son Ltd.
Walsall, Staffs, England

Circle 181 on Reader Service Card

TUBE FITTING

. . . for copper, aluminum tubing

Designation: Selfalign

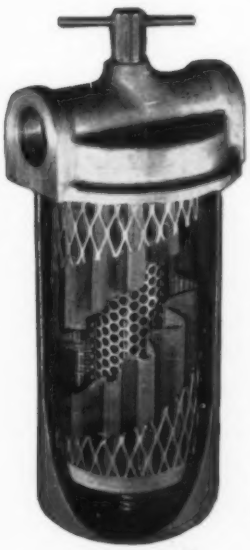
Features: Fitting can be installed without disassembly, and dual sealing principle assures positive, leakproof connection. Tubing is inserted in fitting until it bottoms and the nut is then tightened. The sleeve grips the tubing over a broad area for a surface-to-surface seal, while a thin razor edge and guiding shoulder form a line-to-line seal with the tubing as the nut is tightened. Fitting is suited for low and medium pressure applications and is available in union, union tee, union elbow, male and female connectors, male and female elbows, male tees for pipe on run and pipe on branch. Sizes ⅛, 3/16, ¼, 5/16, ⅜, and ½ in brass are standard. Aluminum fittings can also be supplied.

The Weatherhead Co.
Fort Wayne, Indiana

Circle 182 on Reader Service Card

Continued on page 52

SUMP TYPE
(cutaway)



LINE TYPE
(cutaway)

Here's What Users Have to Say About
MARVEL Synclinal FILTERS

U. S. STEEL CO., Irvin Works Three-Stand Cold Reduction Mill—

"Marvel Synclinal Filters are a part of the mill's main hydraulic system which operates Coil Cradle as well as other hydraulic machines".

JONES & LAUGHLIN STEEL CORP., Aliquippa Works—

"Marvel Synclinal Filters proved their effectiveness when one of the motors on the hydrostatic pipe testers broke down. A brass fitting was chewed up and jagged pieces of brass were carried into the oil stream. Any small piece of brass could also have caused a great deal of damage to the expensive equipment. However, when the unit was inspected, it was found that all metal particles had been filtered out by the Marvel Synclinal Filters and no damage had been done to the equipment nor was there any loss in operating time. Two filters are installed on each circuit so that one can serve as a by-pass while the other is being cleaned. Although it takes only about fifteen minutes to clean the monel filter insert, even this short interruption in production could be costly in an operation of this size".

P. R. MALLORY PLASTICS, INC.-Supt. of Maintenance Leo Paszkiet reports—

"We have one injection molding press here that was giving me a lot of trouble. In order to maintain our 24-hour-a-day schedule, I had to stop it every two or three weeks to service the filters. It was a troublesome, time consuming job but it had to be done. Even then, the machine never seemed to reach the productive capacity I knew it was capable of. Well, I had enough of that so I pulled out the original 3 filters and replaced them with three 50 G.P.M. Sump type, Marvel Synclinal Filters. That was over 10 months ago. During all this time the machine was operating faster and smoother than it ever had before. There was no more slow down of production due to pressure loss, vibration, pump starvation, etc. On the basis of these results, we are installing Marvels on every hydraulic machine in our plant, except of course, those on which Marvel Synclinal Filters were installed as standard equipment by the manufacturer".

Many others reporting similar results are now specifying MARVEL SYNCLINAL FILTERS on all new hydraulic equipment—and Standardizing with MARVEL SYNCLINAL FILTERS on all existing equipment.

For Dependable Protection on All Hydraulic and Other Low Pressure Circulating Systems— Investigate MARVEL SYNCLINAL FILTERS

They Meet J. I. C. Standards

FILTERS FOR ALL TYPES OF FIRE-RESISTANT FLUIDS

Marvel's most recent development is a filter for the efficient filtration of all types of fire-resistant fluids.

WATER FILTERS

Both sump and line type filters have been adapted for use in all water filtering applications. No changes have been made in the basic, balanced, synclinal design.

A SIZE FOR EVERY NEED

Available for sump or line installation in capacities from 5 to 100 G.P.M. Greater capacities may be attained by multiple installation (as described in catalog). Choice of monel mesh sizes range from coarse 30 to fine 200.

IMMEDIATE DELIVERY!

As in the past, Marvel continues to offer Immediate Delivery!

OVER 650 Original Equipment Manufacturers Now Install MARVEL SYNCLINAL FILTERS as Standard Equipment!

Catalogs containing complete data available on request

MARVEL ENGINEERING CO.

7227 N. Hamlin Ave., Chicago 45, Ill. **PHONE: Juniper 8-6023**

Without obligation, please send me data on Marvel Synclinal Filters, as indicated AH-5

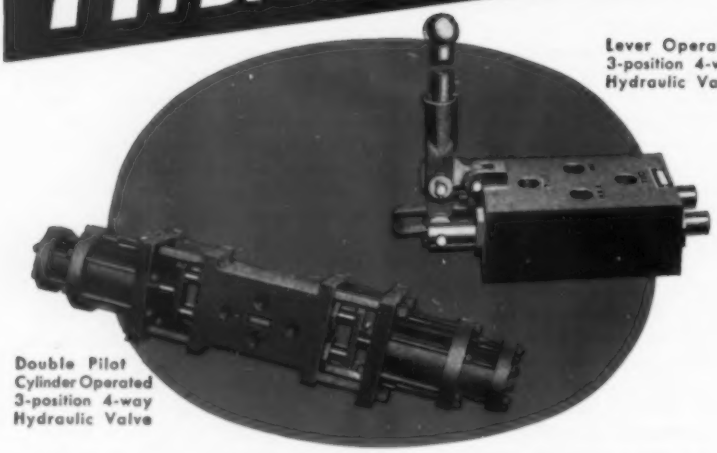
- ☐ Catalog #107—For Hydraulic Oils, Coolants and Lubricants
- ☐ Catalog #301—For WATER
- ☐ Catalog #200—For Fire-Resistant fluids.

Name ..... Address .....

Title ..... City .....

Company ..... State .....

Quick-As-Wink® Hydraulic Valves



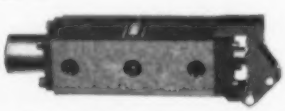
Lever Operated 3-position 4-way Hydraulic Valve

Double Pilot Cylinder Operated 3-position 4-way Hydraulic Valve

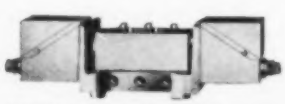
Hand and Pilot-operated Types for Water or Hydraulic Oils to 5000 psi.

• Quick-As-Wink Hydraulic Control Valves meet the most exacting requirements. These valves are fully balanced in any position. Patented design includes hydraulically balanced U-packers. Packers are floated while crossing the valving ports, thus assuring long life, and expanded by internal valve pressure to provide a tight seal. Maintenance is extremely low and usually can be done quickly in the field, avoiding the delay of returning valves to the factory for servicing, or the need of maintaining large standby inventories. For long, dependable, trouble-free service, specify Quick-As-Wink Hydraulic Valves. Write for Bulletin No. 531 and the fully descriptive Data Sheets. They give complete details. Write *today!*

Ask us also about . . .



CAM OPERATED SINGLE PLUNGER VALVE 3/8" to 3/4" sizes. Operated by rotating cam or land on reciprocating device.



DOUBLE SOLENOID "O-TYPE" VALVE for pressures up to 125 psi. Widely used as pilot valves and for operating air cylinders.

Quick-As-Wink®
AIR AND HYDRAULIC
Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 1998 East Pershing St., Salem, Ohio

New Products / continued

PRESSURE GAGE . . . with explosion protection

Designation: Safecase

Design: Gage has solid front which protects the gage face and a thin stainless plate covering the entire

back of the case to relive all explosive pressures. Back plate is held firmly to the case by two holding screws preventing the back plate from becoming detached in the event of a blow out. In experimental tests in which blank cartridges were fired into gage, glass did not crack and back plate folded out to relieve force.

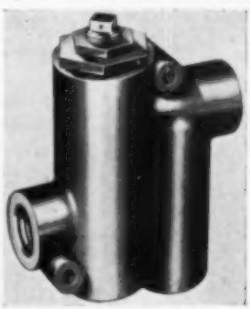
Jas. P. Marsh Corp.
Skokie, Illinois

Circle 183 on Reader Service Card

AIRCRAFT RELIEF VALVE . . . has thermal venting

Designation: Series EA 50004

Features: Valve provides means for controlling maximum system oil temperature as well as maximum system pressure. Unit is basically a 3000-psi relief valve and includes



an integral temperature control element which prevents fluid from exceeding temperature of 270 degrees F.

Design: Temperature control element is immersed in the hydraulic fluid and reacts to a 270-degree

Continued on page 54

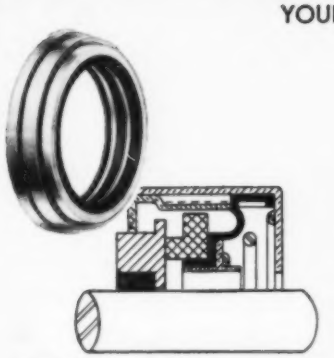
Circle 69 on Reader Service Card

Circle 57 →

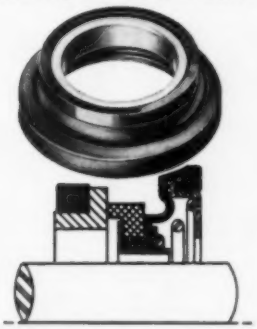
LARGEST STOCK SELECTION AVAILABLE ANYWHERE!

Modern, Mechanical, Face-Type Seals —
Standardized, To Save Time And Money

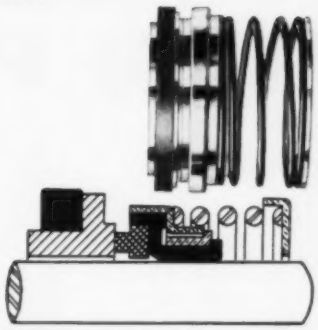
YOUR Sealing Problem Is Solved Here!



STYLE GU — A packaged sealing unit containing both rotating and stationary seal faces enclosed in metal housing. Important applications in **machine tools** and **power transmission equipment.** Stock sizes for shafts .250 through 4.000.

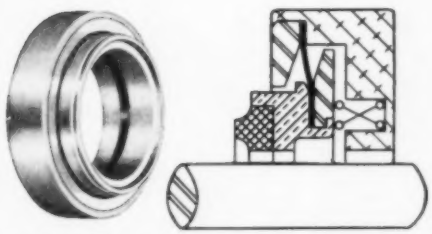


STYLE SGU—A factory-assembled unit-type seal for the small budget user. Widely used in **appliance** field. Stock sizes for shafts .250 through 1.000.

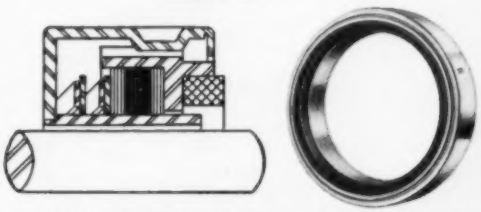


ROTO-FLEX — Rugged flexibility. Only 3 parts. Single or double units. Many applications in **pumps** and **compressors.** Stock sizes for shafts .250 through 4.000.

STYLE RFO—A specially designed Roto-flex seal, for installation outside the stuffing box. Stock sizes for shafts .250 through 4.000



STYLE DPC — A high-speed, carbon-faced seal, for use where lubrication is poor or where shaft RPM and resulting friction are high. Ideal in many **machine tool** applications. Stock sizes for shafts .250 through 4.000.



STYLE HH—Absolute minimal space (both radial and axial) under extreme conditions of temperature, pressure and seal face surface speed. Features pressure balance when fluid pressure is applied internally or externally. Of particular importance to the **aircraft** industry. Stock sizes for shafts .250 through 4.000.

These are only a few of the countless sealing problems now being solved by

GITS SHAFT SEALS

Write for detailed data on any of these standardized stock Gits Shaft Seals.

GITS BROS. MFG. CO.
1846 S. KILBOURN AVE., CHICAGO 23, ILL.

Specialists In Lubricating Devices And Shaft Seals For Almost Half A Century

NEW 5,000,000 lb. TESTING MACHINE WITH HELE-SHAW FLUID POWER

Testing machine stands approximately 60 ft. above and 16 ft. below test floor...weighs approx. 450 tons. Loads are applied hydraulically by a movable cylinder on a stationary piston. Hydraulic control is so sensitive that a candle has been snuffed out without being crushed.

LIKE A SKYSCRAPER on a prairie this new universal testing machine looms supreme in the newly-completed addition to the Fritz Engineering Laboratory, Lehigh University. Designed and built by Baldwin-Lima-Hamilton Corporation, it can apply loads up to 5,000,000 lbs. in either tension or compression.

The heart of this machine's hydraulic system is a Hele-Shaw variable discharge fluid power generator with a leakage compensator control. The generator is operated remotely for varying discharge from zero to maximum in direct proportion to the operator's input signal. In addition, it maintains constant output at any discharge setting regardless of the system pressure.

Whatever your problem in high pressure hydraulic pumping systems, American Engineering Company can probably save you time and expense in planning and construction. Write for full data about Hele-Shaw for variable displacement (pressures to 3000 psi) or Hydramite for constant displacement (pressures to 5000 psi).

AMERICAN ENGINEERING COMPANY

DEPT. P-141, WHEATSHEAF LANE & SEPVIVA ST., PHILADELPHIA 37, PA.

Canadian Subsidiaries: Affiliated Engineering Corporations, Ltd., Montreal, P. Q.... Bawden Industries Ltd., Toronto, Ont.

AE products are: Taylor, Perfect Spread and Vibra-Grate Stokers, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers, Marine Deck Auxiliaries.

New Products / continued

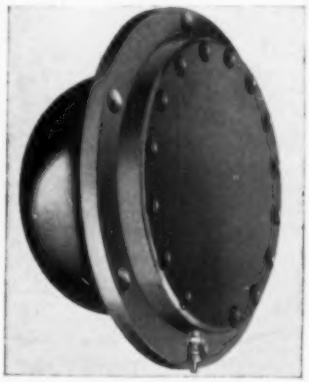
temperature to unseat a poppet which vents the relief valve and opens it at a pressure much lower than its relief setting. With the relief valve vented, pump delivery is unloaded freely back to the reservoir at very low pressure allowing the oil to cool. The valve is for use with ½-inch tubing. Full flow rating is 22 gpm at 3700 psi. Relief pressure and temperature settings can be provided to meet a desired specification.

Vickers, Inc.
Detroit, Mich.

Circle 184 on Reader Service Card

ACCUMULATOR . . . has unique diaphragm

Features: Accumulator diaphragm only flexes and is never stretched. Unit operates indefinitely without loss of pre-charge pressure which is supplied by nitrogen



or air. Flange mounted accumulator permits easy installation and can be used successfully in almost every type of production equipment.

Application: Typical applications for the accumulator are traversing mechanisms, indexing turrets for high speed lathes, clamping and actuating devices of all types.

John S. Barnes Corp.
Rockford, Illinois

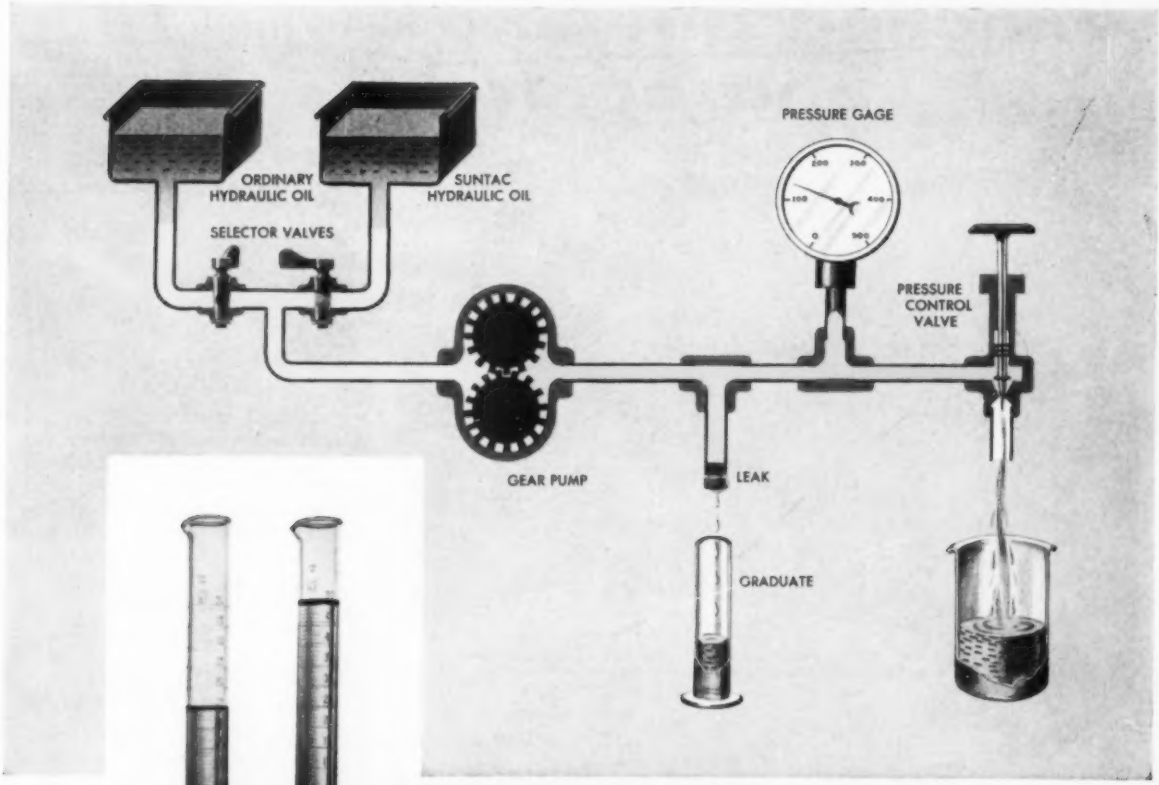
Circle 185 on Reader Service Card

FLEXIBLE COUPLING . . . is radially removable

Designation: C-R

Features: Coupling provides easy assembly and disassembly and is lubrication free. Six sizes are available from 2.58 to 29.6 hp at 100 rpm. All models feature reversible cushions, so that the cushions can

Continued on page 56



The leak rate of ordinary oil vs. Suntac was measured in test machine simulating a typical leak in a hydraulic system. Oil viscosities were equal, time and pressure conditions identical. The simple act of switching from the ordinary oil to Suntac, *without any other changes*, reduced oil leakage by 50%.

PRESSURE SYSTEM DESIGNED TO LEAK PROVES SUNTAC CUTS OIL LOSSES UP TO 50%

If you're having troubles with excessive oil leakage, a Suntac® oil can help you. Because of their unusual anti-leak characteristics, Suntac oils reduce oil consumption up to 90%, users report.

Suntac oils will not gum up or otherwise harm circulating systems. These oils are high-quality petroleum products with a life expectancy longer than that of ordinary hydraulic and circulating oils.

A change to a Suntac oil can lower your oil costs... improve housekeeping... result in safer working conditions.

Your Sun representative can tell you more about Suntac oils. Or write for Technical Bulletin 23. Address SUN OIL COMPANY, Philadelphia 3, Pa., Dept. AH-5.

SUNOCO

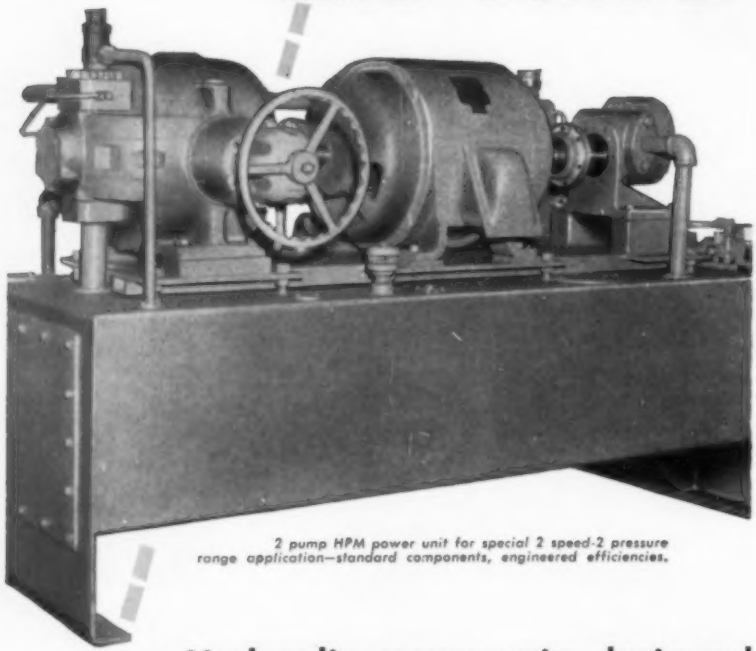
INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY Philadelphia 3, Pa.

©SUN OIL CO.

IN CANADA: SUN OIL COMPANY LIMITED, TORONTO AND MONTREAL

exacting power and control



2 pump HPM power unit for special 2 speed-2 pressure range application—standard components, engineered efficiencies.

Hydraulic power units designed to your particular specs

Whether your requirements call for standard hydraulic power or engineered, multi-pressure power systems, H-P-M engineers have the background of experience for successful installations. Design for maximum efficiency—tailor your hydraulic system to exact minimum-maximum needs with H-P-M standard components. Get constant and variable delivery pumps, pressure and directional valves, cylinders and system accessories from one proven source. Make H-P-M your hydraulic component headquarters.

HPM

HYDRAULIC POWER DIVISION
THE HYDRAULIC PRESS MFG. CO.
Mount Gilead, Ohio, U.S.A.

New Products continued

be reversed on unidirectional loads to double their service life.

Design: Radial removability is accomplished by special cushions cut so they are held in position by a standard Type C collar when the

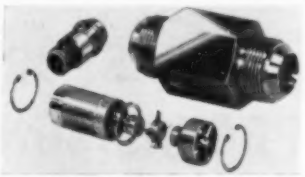
coupling is assembled. When the collar is removed the cushions can be easily removed. This allows the coupling half and connected shaft to be rotated so that the intermeshing jaws slide into the stationary coupling half which is not removed.

Lovejoy Flexible Coupling Co.
Chicago, Illinois

Circle 186 on Reader Service Card

TURBINE FLOW METER . . . has high accuracy

Design: Meter consists of fluid-driven rotor mounted in a short housing installed in the pipe line. Rotor turns at a speed directly proportional to fluid velocity. Blades of rotor are of magnetic material, and as each blade passes a pickup



coil containing a magnet, it induces an electrical pulse. The number of pulses produced is directly proportional to the speed of blade rotation and number of blades.

Features: Meter gives precise flow rate measurement ±½% up to 100,000 pounds per hour at specific gravity 1.0. Range is 20 to 1. Accuracy is not affected by piping configuration. Maximum pressure drop is 7 psi. Flow meter is furnished in standard sizes of ½, ¾, 1, 1½, and 2 inches with maximum capacities from 9 to 210 gpm.

Fischer & Porter Co.
Hatboro 35, Pa.

Circle 187 on Reader Service Card

For more NEW PRODUCT reviews turn to page 137

Hot out of the Oven

*Annealing oven, that is

Hydraluster

...The New BRIGHT FINISH Hydraulic Seamless Steel Tubing

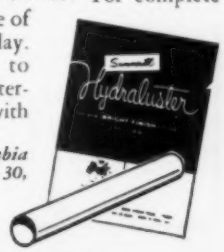
SILVER-BRIGHT FINISH Summerill *Hydraluster* is a *new* steel tubing with a smooth, *bright*, annealed finish . . . a finish that will help you reduce your finishing costs, will give you a cleaner-looking and more attractive product, and will help you or your customer reduce cleaning and maintenance time. *Hydraluster* has the same silver-like finish *inside*, too, to reduce friction to a minimum.

CLEANER This new annealed finish—outside and inside—eliminates oxidation with its resultant flaking inside the tube. Inspection/cleaning costs are therefore minimized.

FATIGUE-RESISTANT Not only does *Hydraluster* present an attractive appearance, but it has the strength to better resist effects of vibration and metal fatigue. It can be bent sharply without flattening; withstands flaring without developing cracks. In fact, it exceeds J.I.C. specifications for steel tubing.

FREE SAMPLE AND DESCRIPTIVE BOOKLET For complete details, and for a free testing sample of *Hydraluster*, write or phone us today. We'll welcome the opportunity to *show* how you can make a better-*looking*, better-*lasting* product with Summerill *Hydraluster* tubing.

Summerill Tubing Division, Columbia Steel & Shafting Company, Pittsburgh 30, Pennsylvania.



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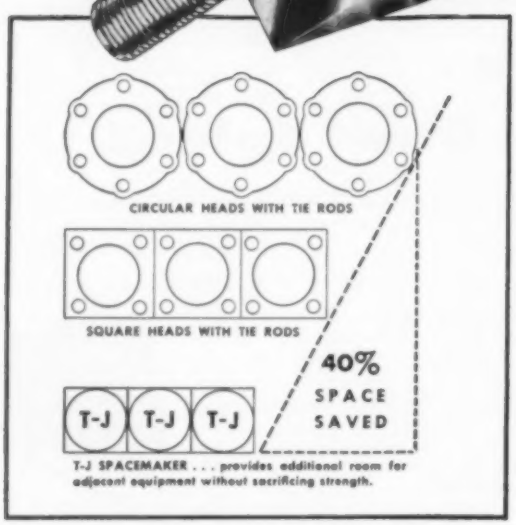

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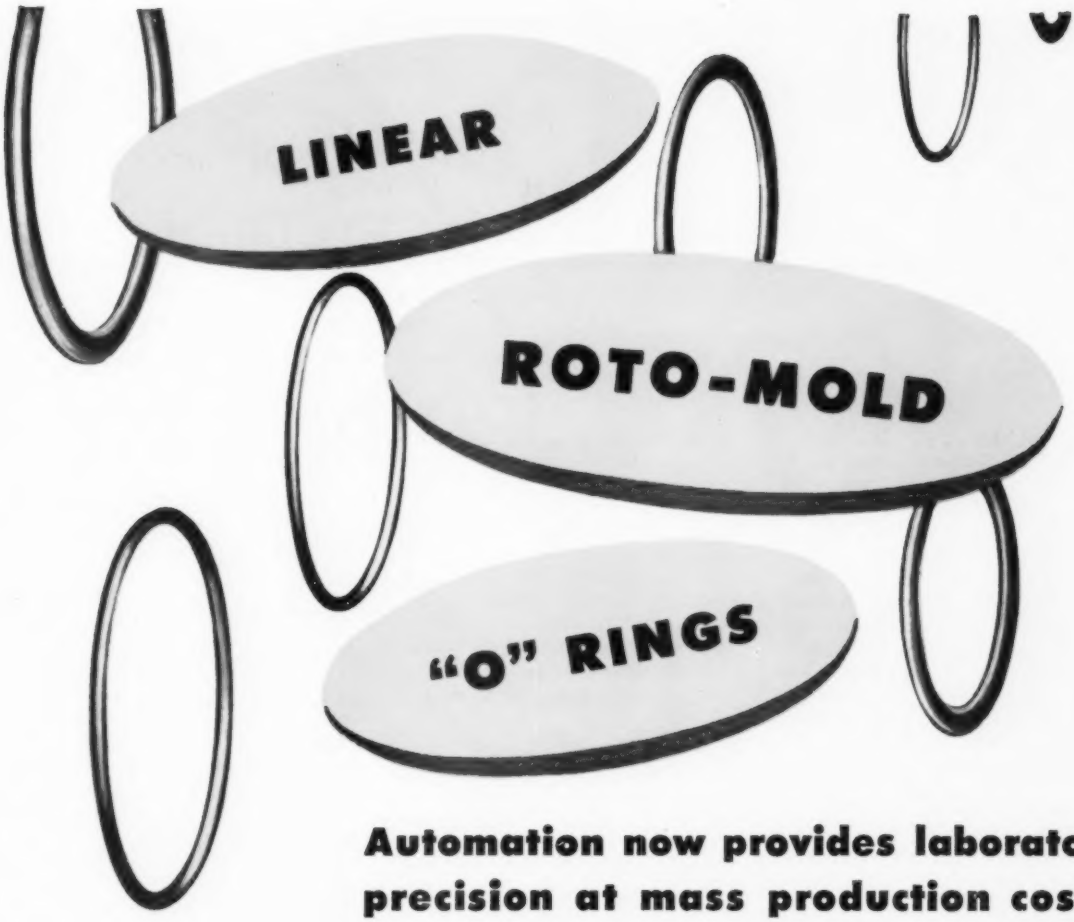

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Useful Literature

For your free copy of publications reviewed, fill in the reader service card

OIL VALVES . . . Fluid Controls, Inc. has released new catalog sheets on their relief valves, dual relief valves, pilot check valves, and double pilot check valves showing outline dimensions, pressure vs. flow charts, and indicating pipe sizes. These valves have been field tested before being included in the company's catalog and have been proved in actual installations. The low pressure relief valves have been used successfully on machine tools to provide a back pressure for the pilot control systems. The dual relief valves are generally used with hydraulic motors to limit the shock pressure when the motor is suddenly stopped or reversed. The pilot check valves are used on mobile equipment to hold a cylinder without leakage.

Circle 230 on Reader Service Card

AIRCRAFT ACTUATING SYSTEMS . . . are included in a brochure from Breeze Corporations, Inc. These hydraulic packages for actuating landing gear, trim tabs, wing flaps, pilots' seats, cowl shutters, antennae and allied mechanisms are available in a wide range of tested and proved types.

Circle 231 on Reader Service Card

FLEXIBLE SEALS . . . of the reed, vee, flat, and rotary bellows type are fully specified in Bulletin 827 from Fulton Sylphon Div. Robertshaw-Fulton Controls Co. The bulletin outlines features and advantages of the various types of seals and presents applications and typical installations. Installation drawings for each type are shown with a discussion of construction, materials, and operation. The reed seal is constructed of a very thin, flexible, molded or stamped ring with the cross section of a frustrum of a cone, the included angle being 70 degrees. These seals are either metallic or plastic. The bellows type seal is a device used to prevent leakage of a liquid or gas around a rotating shaft where the shaft extends from the inside to the outside of an enclosure.

Circle 232 on Reader Service Card

PRESSURE CONTROLLER . . . in ranges from 0-50 to 0-200 is discussed in Bulletin 7040 published by Minneapolis-Honeywell Regulator Co., Industrial Div. The controlled air pressure gage, visible through a window on the cover, is screwed into the top of a diaphragm-type pilot relay valve. This pilot relay valve gives fast, positive control action with low air consumption. A control provides narrow band proportional control with manual reset. Views of internal construction are shown in the bulletin.

Circle 233 on Reader Service Card

SOLENOID VALVES . . . are the subject of a comprehensive catalog from Atkomatic Valve Co., Inc. describing the company's complete line of electrically operated two-way valves. The catalog lists dimensions, specifications, pressures and applications of solenoid valves in bronze and stainless steel, as well as numerous coil and flow charts. Included is a description of a bypass valve which permits external adjustment of operating speed. Where pressure ranges of 0 to 150 psi are indicated, the application of the bronze, semi-direct lift valves for ½ to 1-inch pipe sizes is presented. Bronze and stainless steel valves for high pressures ranging to 3000 psi are available for pipe sizes from ½ to 1½ inches.

Circle 234 on Reader Serivce Card

MICRONIC FILTER . . . which is continuously cleanable and filters down to 40 microns is discussed in Catalog SAK-057 released by The Cuno Engineering Corp. Unit handles flows of over 50 gpm with less than 3 psi pressure drop. Combing-action design of the filter provides positive cleaning, and the all-metal construction of carbon or stainless steel prevents channeling or rupturing. The catalog presents clear illustrations of the filter design and operation and includes a chart to show flow rates at various pressure drops and viscosities.

Available housings for the filter are also specified for either manual or motor driven cleaning.

Circle 235 on Reader Service Card

GEAR MOTORS . . . Representative designs produced by Reliance Electric & Engineering Co. are outlined in Bulletin No. E-2408 titled "Reduce Speed." These gear motors incorporate electric motors to the new NEMA Standards and have completely redesigned gear heads. The wide selection of types, mountings, enclosures, and ratios is presented, and a detailed cutaway view points out the features and design details. The simplified maintenance by easy replacement of motor and gear is illustrated, with a listing of the types of gear motors, types of service, output speeds, horsepowers, electrical characteristics, enclosures, and types of mountings.

Circle 236 on Reader Service Card

For more reviews of FREE LITERATURE turn to page 158

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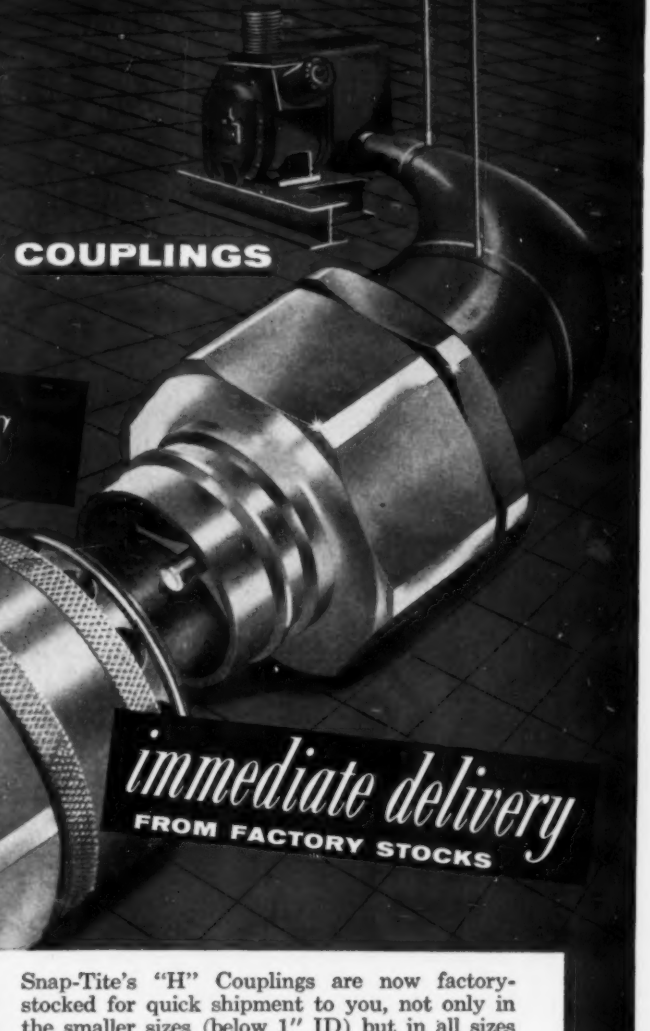
QUICK-CONNECT QUICK-DISCONNECT COUPLINGS

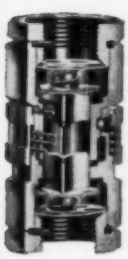
in larger sizes

immediate delivery
FROM FACTORY STOCKS



SNAP-TITE'S "H" COUPLING, SIZE FOR SIZE, IS THE SMALLEST COUPLING WITH HIGHEST STRENGTH AND HIGHER EFFICIENCY

Snap-Tite's "H" Couplings are now factory-stocked for quick shipment to you, not only in the smaller sizes (below 1" ID) but in all sizes up to and including 3"—in steel, brass, aluminum, and 303 and 316 **Stainless Steel.** And "H" Couplings can be made to your order, up to 10" ID.



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Recessed valve washers . . . fluted valve stems . . . valve stops with minimum flow restrictions . . . large inside diameter—allow maximum flow capacity with lowest pressure drop.

See the Snap-Tite representative in your city or write for Bulletin 240.

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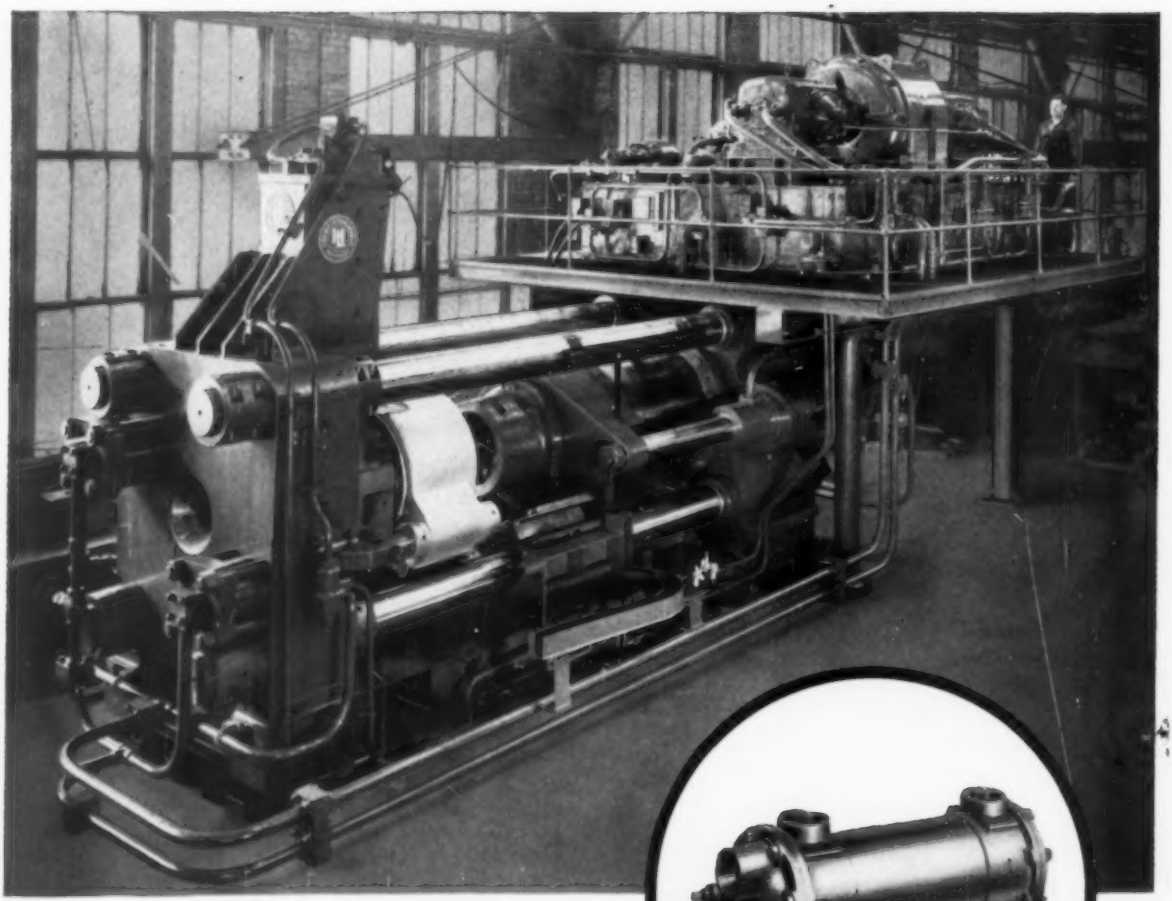

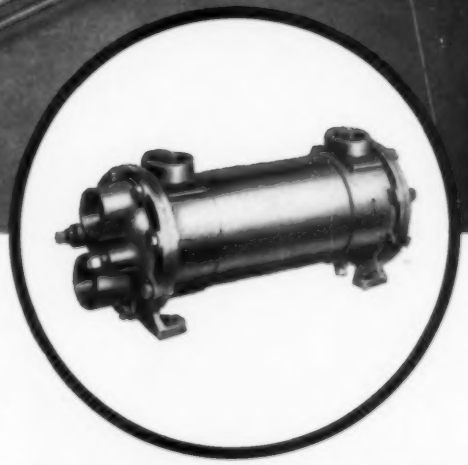

ROSS EXCHANGER

keeps this Loewy Hydropress operating at rated 2200-ton capacity

Completely piped, wired, tested and ready to go, this Loewy Hydropress High-Speed Oil Hydraulic Extrusion Press includes a Ross Type BCF Heat Exchanger as part of the "Package."

The hydraulic oil system is thereby protected at all times, against overheating. Ross Exchangers are "efficient and reliable, there is a large range of sizes to choose from," say Loewy Hydropress Engineers.

Unequaled for thermal efficiency and ruggedly built to withstand punishing hydraulic shock, they're widely used on practically every type and make of hydraulic machinery.

Pre-engineered and fully standardized, Ross Exchangers are available in a wide range of sizes. For detailed information, write for bulletin 1.1K5.

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Automation with the Bonnot *Hydromotor*

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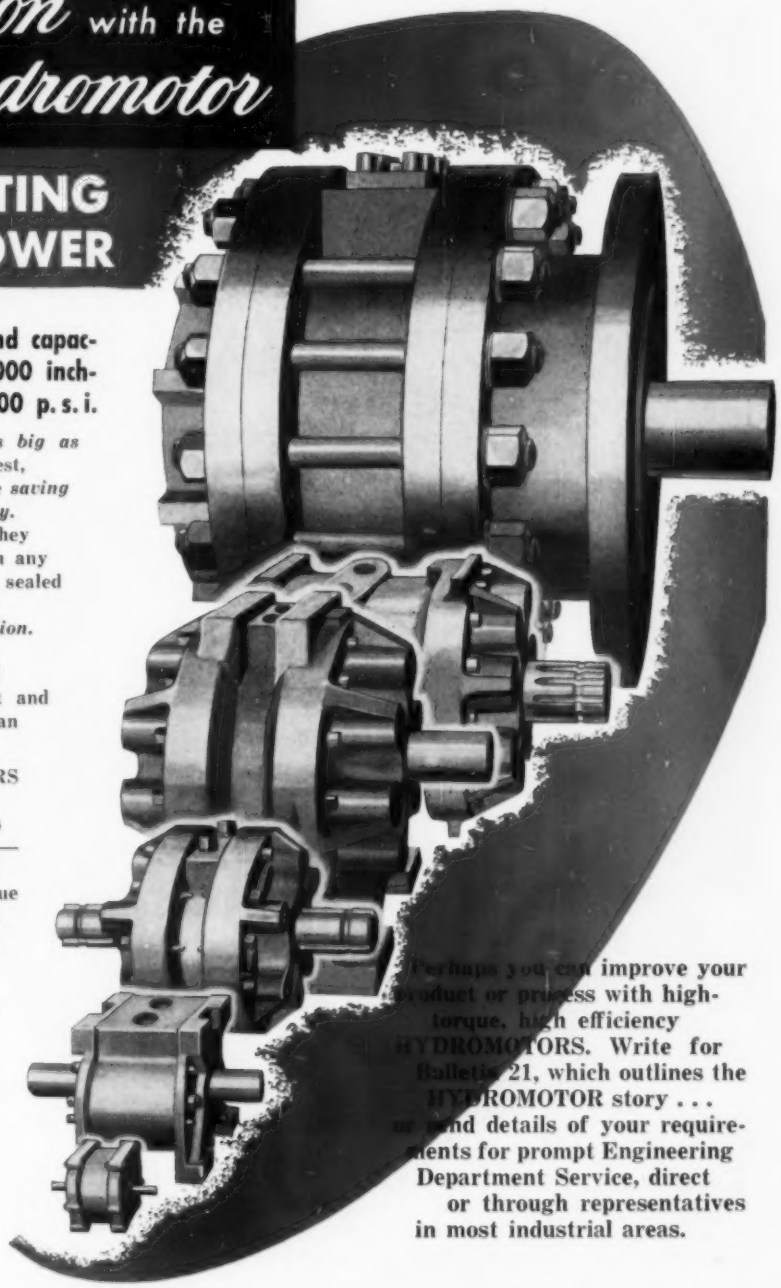
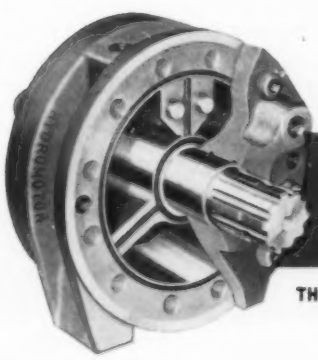
Wide choice of models and capacities from 150 to 1,000,000 inch-pounds of torque at 1000 p. s. i.

From the smallest *(only as big as your fist)* through the largest, *Bonnot* HYDROMOTORS are *saving users time, space and money.* Compact and lightweight, they can be mounted anywhere, in any position and are completely sealed and self-contained to insure *dirt-free, trouble-free operation.* HYDROMOTORS eliminate expensive, bulky mechanical linkages, installation is fast and easy, maintenance is cut to an absolute minimum.

With Bonnot HYDROMOTORS *reliable automation* can be achieved more simply. This reciprocating rotary actuator—operating with air, water or oil—develops instant full torque in either direction. Standard units travel 280° and develop 150 to 500,000 inch-pounds of torque. Double vane units—with maximum travel of 100°—approximately double the above torque values of the single vane unit IN THE SAME SIZE HOUSING. Special sizes are custom-built to individual specifications.



Perhaps you can improve your product or process with high-torque, high efficiency HYDROMOTORS. Write for Bulletin 21, which outlines the HYDROMOTOR story . . . or send details of your requirements for prompt Engineering Department Service, direct or through representatives in most industrial areas.



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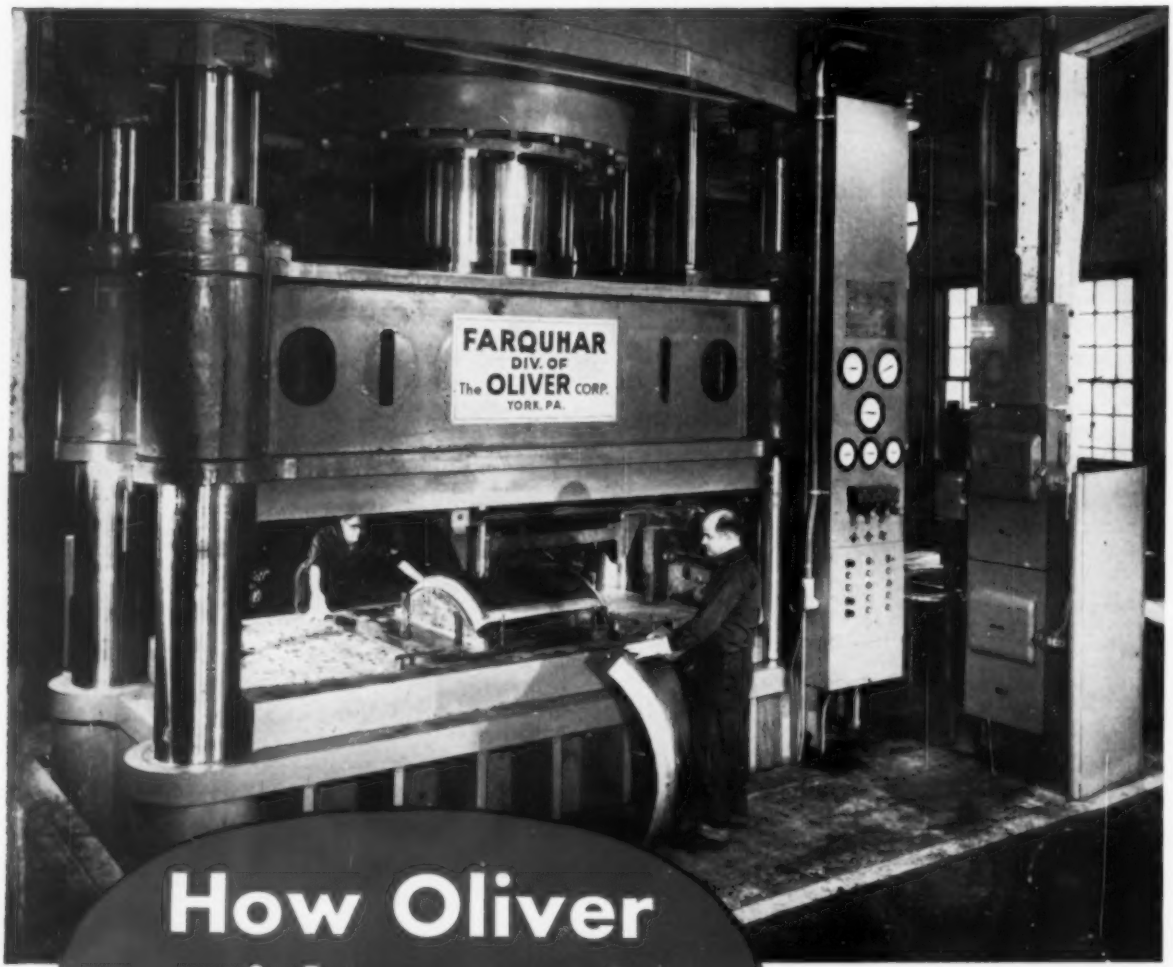

How Oliver avoids pressing problems

THE illustration shows a 3,000-ton Farquhar press recently installed by the Oliver Corporation, Battle Creek, Michigan, to speed production of its line of farm and industrial equipment. *Texaco Regal Oil R&O* is the hydraulic fluid.

Oliver's choice of *Texaco Regal Oil R&O* was only logical. Texaco Lubrication Engineering Service recommended it some years ago for other hydraulic equipment and *never once* has there been the slightest trouble due to sludge, rust or foam.

Tests prove that *Texaco Regal Oil R&O* has *more than ten times the oxidation resistance* of ordinary turbine-quality oils used in hydraulic service—far greater ability to prevent rust, sludge and foam.

There is a complete line of *Texaco Regal Oils R&O* to meet the requirements of all types and sizes of hydraulic equipment. A Texaco Lubrication Engineer will gladly help you select the proper one. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

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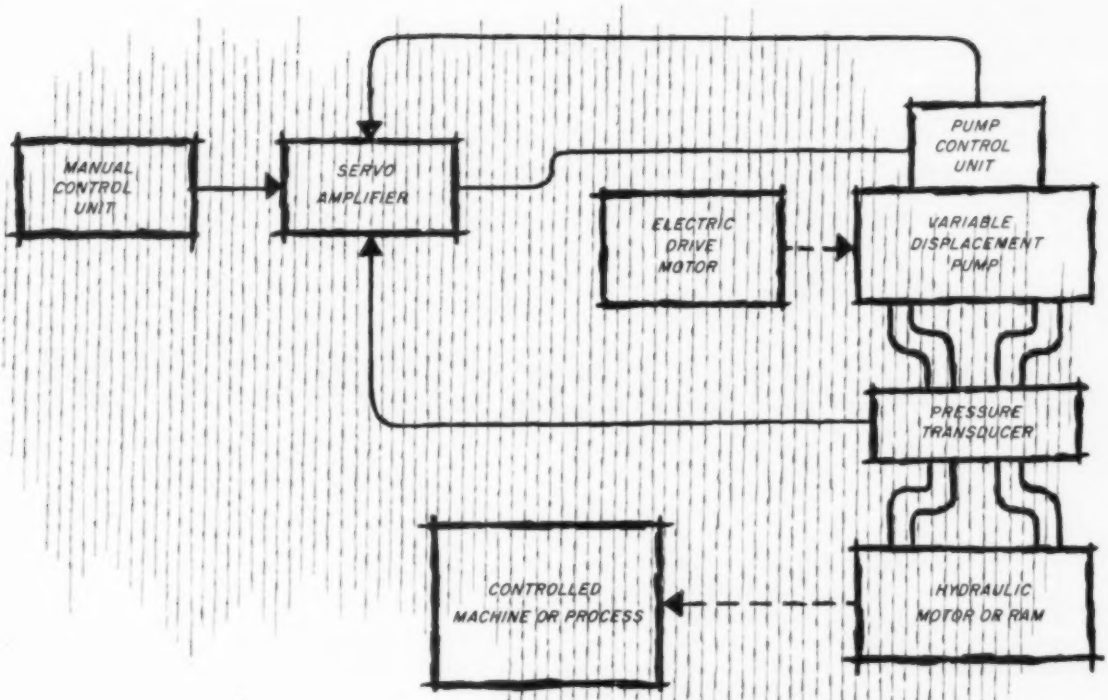


Where to with Hydraulic Servos?

INDUSTRIAL applications of hydraulic servosystems are scarce. But the potential for growth is tremendous. This growth goes hand-in-hand with the increasing number of automatically controlled production facilities.

Much has been learned in recent years from military applications of servos. The result is packaged components which offer practical possibilities for designers of industrial equipment. Increased use will lower the cost of these precision components.

Wide application of hydraulic servosystems in industry depends on the machine designer. His efforts to understand the performance of servos and to know about the availability of components will pay off in new profitable uses. ▼▼▼

On the following pages are articles aimed toward acquainting designers of machine hydraulic circuits with the fundamentals of servos, the construction and operation of servovalves, selection of components, and typical applications.

What motion or travel must be obtained?
What is the maximum required velocity and acceleration?
What accuracy is required?
What's the range and character of the command signal?
These are a few of the questions which must be answered when working on design and application of . . .

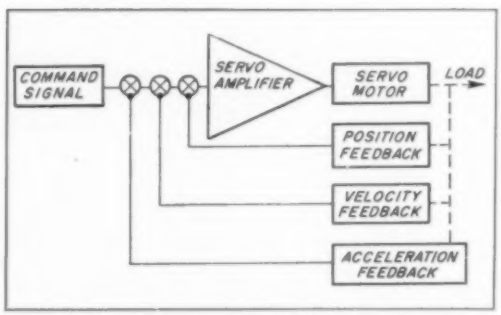
ELECTRO-HYDRAULIC SERVO SYSTEMS

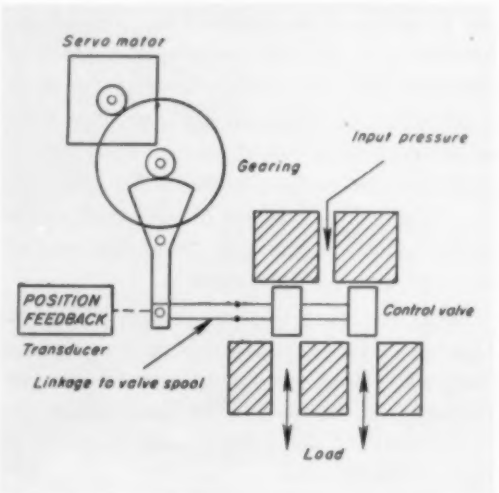
• By J. Wesley Broome

1 **FEEDBACK CONTROL:** Mechanical position, velocity, or acceleration is controlled in response to a variable input command or reference. This system operates until the output signal corresponds to the input command.

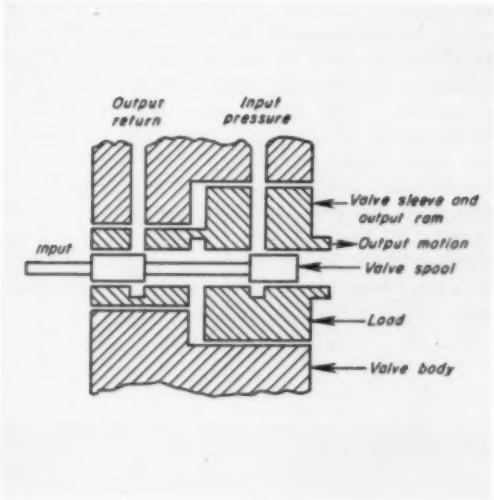
Control of complete machine usually involves one or more servomechanisms connected in series and parallel combinations. To position the shaft of an electrical servo motor in response to an electrical input signal, an amplifier increases the power of the input signal to the level required to operate the motor. Since the speed of an electric servo motor is characteristically proportional to the voltage applied to its windings, the servo motor will run at a speed proportional to the electrical input signal to the amplifier. To make the motor shaft come to rest at a given position, it is connected to a device that will transform the mechanical position of the shaft to an electrical signal compatible with the input signal. The two signals are compared until they are equal and opposite, at which time the voltage applied to the servo motor is zero and the system is in equilibrium. To make the system reach a new position with greater speed and accuracy—the incoming signal to the amplifier of servo motor may be increased so that smaller differences between input and output will cause corrective motions of the servo motor.

2 **SERVO VALVE:** Versatility and flexibility of electronic control is combined with the high power, extreme accuracy, and fine resolution of hydraulic control. An electrical servo system operates this throttling-type valve. Mechanical motion of the electro-mechanical feedback control system is converted to a hydraulic flow which may be controlled in proportion to the electrical input signal. Power output of the servo motor can be increased from a few thousandths of a horsepower to several fluid horsepower. This type of control system may be used to regulate speed of a hydraulic cylinder or motor.

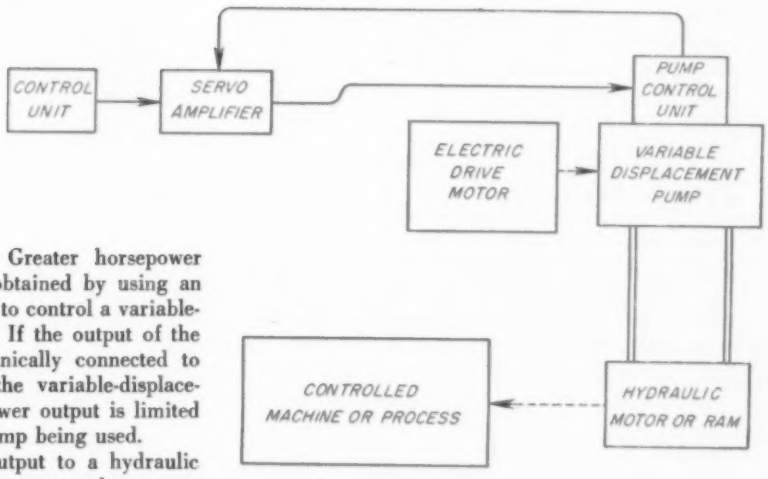




J. Wesley Broome, *Manager Automation Section, Raytheon Manufacturing Co., Waltham, Mass.*



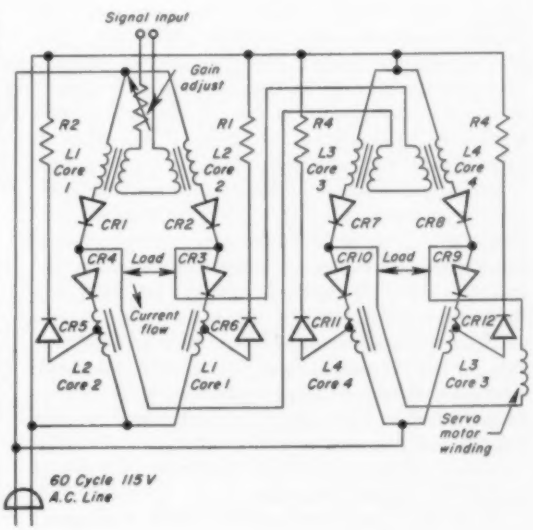
3 **HYDRAULIC AMPLIFIER:** Large amplification in the output force compared to the input force can be obtained with this valve. Outer portion or sleeve of the valve is free to move with respect to the inner portion or spool of the valve. A ram is connected to the valve sleeve. The few hundredths of a horsepower from a servo motor as an input may be increased to a few horsepower out with this hydraulic valve and ram. This hydraulic amplifier, is a closed-loop servo control system in that the output position of the ram is either equal, or proportional to, the input position of the valve spool. By combining this system with the servo amplifier and servo motor, an output motion is obtained from the hydraulic ram that is proportional to the electrical input or command signals. Feedback control systems of this type will have outputs of several horsepower and will respond up to frequencies in excess of 100 cycles per second.



4 **PUMP CONTROL:** Greater horsepower amplification can be obtained by using an electro-hydraulic servo system to control a variable-displacement hydraulic pump. If the output of the hydraulic amplifier is mechanically connected to the stroking mechanism of the variable-displacement pump, the fluid horsepower output is limited only by the capacity of the pump being used.

By connecting the pump output to a hydraulic motor, the fluid horsepower is converted to a mechanical motion proportional to the electrical command signal or pump displacement. To control the position of the load, a transducer that produces a voltage proportional to the position of the load may be used. This electrical signal is fed back and compared to the command signal. The output motion continues until the difference between the command signal and the feedback signal approaches zero.

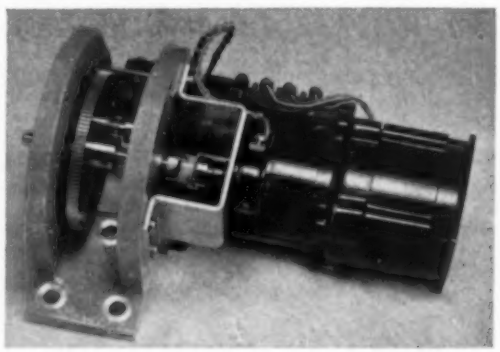
5 **MAGNETIC AMPLIFIER:** This simplifier schematic of a magnetic amplifier is used in industrial control systems to increase the power level of the electrical system. It consists of two stages with identical circuits, the output stage possessing greater power handling capacity than the input stage. The input stage consists of core 1 and core 2, each with two windings (L1 and L2); bridge rectifiers CR1, CR2, CR3, and CR4; and reset rectifiers CR5 and CR6. The core material is such that at saturation a large change in perme-



ability occurs almost instantaneously, which changes the impedance of the L1 and L2 windings from a very high value to a very low value which represents principally the d-c winding resistance.

When the supply voltage is positive, and core 1 becomes saturated while core 2 remains unsaturated, current will flow through the load. However, if core 2 becomes saturated while core 1 is unsaturated, current will flow through the load in the opposite direction. Therefore, if the order in which the cores saturate and the time and the cycle at which they saturate are controlled, the voltage applied to the load will consist of polarity-reversible pulses of variable width. The output pulses from the first stage of the magnetic amplifier are used as the input signal to the control windings of the second stage; and the output voltages from the second stage are used to supply power to the servo motor. Less than 0.1 watt of power into the magnetic amplifier will be increased to approximately 15 watts of electrical power output from the magnetic amplifier into the servo motor.

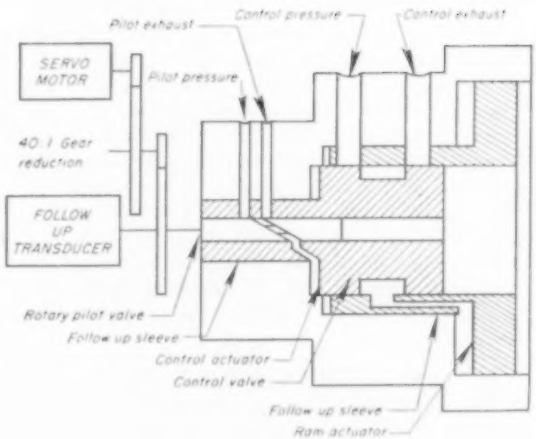
6 **SERVO MOTOR:** This is a standard 2-phase type motor which will deliver approximately 5 watts of power output for 15 watts input. It has an attached tachometer which develops an electrical signal proportional to the motor speed, which is fed back into the servo amplifier to improve the overall performance of the system. This combination will respond to input or command signals varying to rates up to 5 cycles per second. The servo motor is controlled in position by gearing the motor, output to a mechanical-to-electrical transducer such as a potentiometer, synchro, or linear differential transformer so as to provide an electrical voltage directly proportional to the servo motor shaft position. This electrical signal is subtracted from the command electrical signals that come from the control unit. The difference between these signals is amplified and used to control the servo motor, which will run until the difference between the input and output signals is zero.



7 **TWO STAGE HYDRAULIC AMPLIFIER:** Rotary output of the servo motor is geared to a rotary type hydraulic pilot valve. The gearing and linkage ratios depend on the reaction forces on the pilot valve, the total motion required by the pilot valve, and the frequency-response and accuracy requirements of the system. If a small pilot valve is used that will deliver one fluid horsepower or less, reaction forces on the servo motor are comparatively small and a gear ratio between 30 and 50 to 1 may be used. If the reaction forces are large, larger gear ratios must be used to maintain the system stability. This results in a lower rate at which the valve may be moved.

This control system now has a valve opening and a flow directly proportional to an electrical input signal for static operation and an opening that is proportional to this signal, and modified by the velocity and acceleration of the signal, for dynamic operation. This control flow may now be used to control the velocity of a ram.

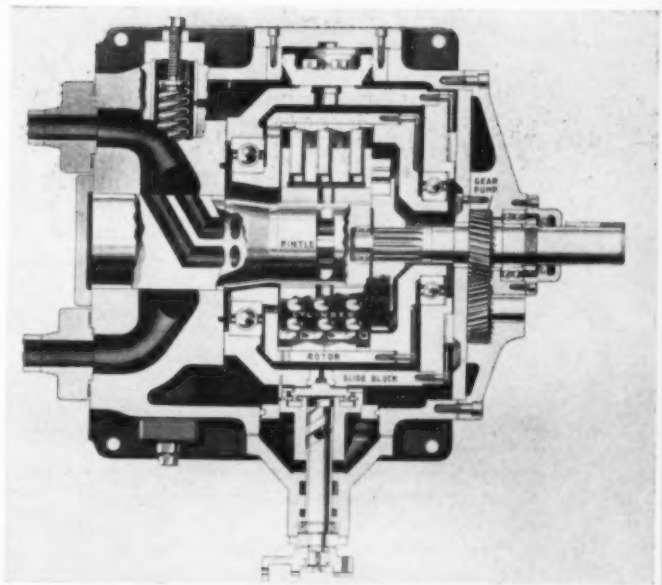
For applications requiring the control of the position of the ram, the output position may be electrically or mechanically introduced into the feedback control system. The same type of transducer may be use for this measurement as was used to measure the position of the servo-motor shaft.

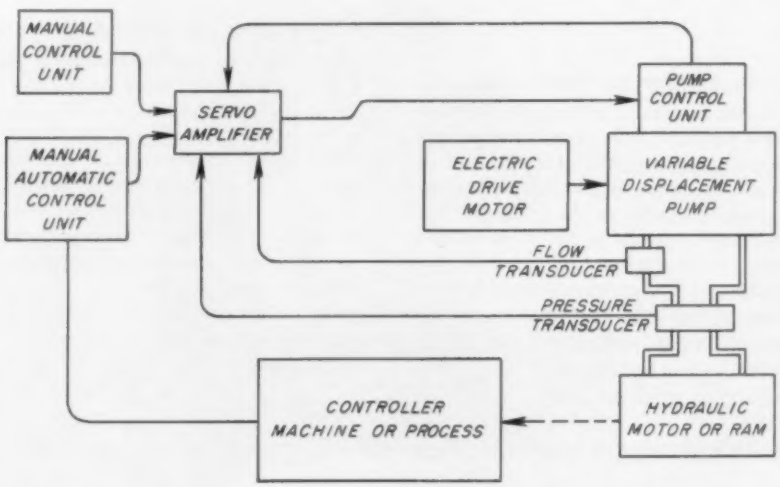


8 **VARIABLE DISPLACEMENT PUMP:** This pump has inherently a higher natural frequency, greater stiffness, and a greater speed range for its size than any electric motor or similar high power amplifying devices. Raytheon control systems are designed to utilize radial piston pumps manufactured by the Oilgear Company which will deliver up to 150 hp.

These radial-piston type pumps consist of a pintle, a cylinder barrel with seven or more pistons, a reaction ring, a rotor, and a slide block. The slide block, which is mounted between ways in the pump case, carries the complete rotor unit and is connected to the control mechanism to vary the stroke of the pistons.

The output of the pump, which is directly proportional to the displacement of the slide block from its neutral or zero position, may be used to control the position, velocity, or acceleration of a ram or hydraulic motor. The speed of the ram is directly proportional to the displacement from neutral of the pump slide block, minus the leakage losses in the pump and motor. The leakage losses are proportional to the load on the ram or motor.

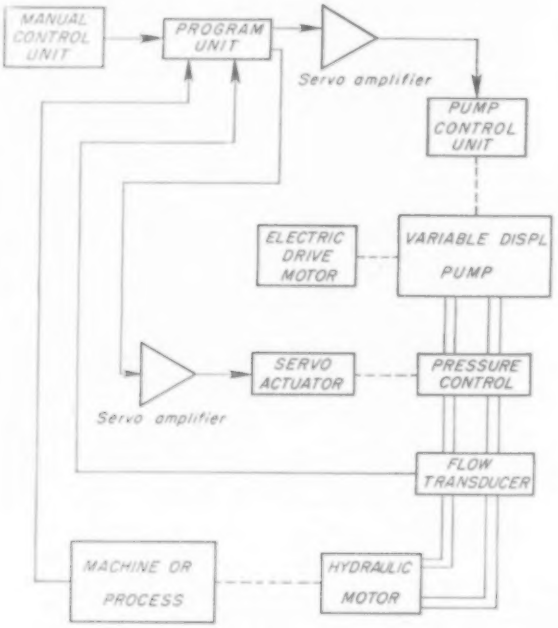




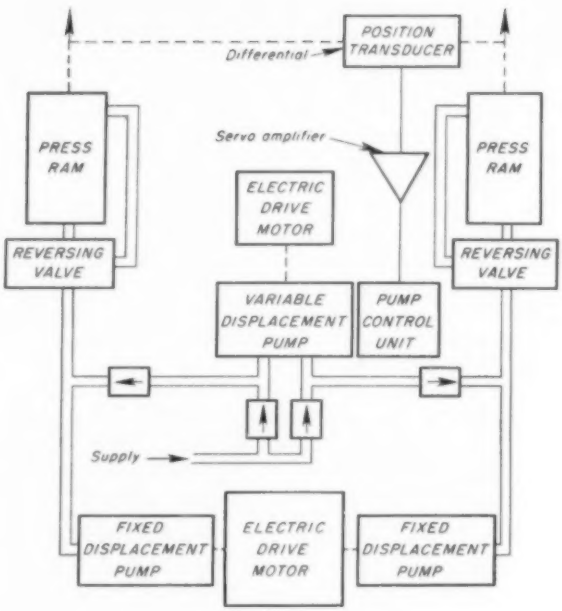
9 **PRESSURE AND FLOW FEEDBACK:** If it is desired to maintain a constant torque or force from the motor or ram, the pressure output of the pump may be measured and compared with the input signal from the control unit. The servo system will then control the pump slide block proportionally to this pressure so as to maintain the output constant at any desired level within the ratings of the servo system. If it is desired to control the acceleration of the load, the velocity of the load may be measured and integrated or the pressure of the hydraulic system may be measured and fed back into the servo system to control or limit the acceleration of the load. By combining the pressure and flow signals, various functions and relationships between the speed and acceleration of the load may be controlled as a function of time, pressure, machine position, process reaction etc.

If it is desired to maintain a constant or controlled speed of the load, an electric or hydraulic tachometer may be used to measure this speed and comparing the output with the input signal from the control unit, cause the servo system to maintain a constant speed practically independent of load.

ELECTRO-HYDRAULIC SERVOSYSTEMS



10 **WEB TENSION CONTROL:** This control system, with programmed pressure, flow and process feedback is for a web control application. The speed and torque must be adjusted as a function of the diameter of the roll to prevent damage of the material in the center as the roll size increases. The system consists of the basic control elements together with a program unit that controls the pressure and flow relationship as a function of the size of the roll. In this way, as the size of the roll increases, both speed and torque may be decreased.



11 **SYNCHRONIZED MOTION:** The problem of synchronizing the position of two press rams as unbalanced loads occur may be solved by measuring the position of the rams with a differential position transducer which provides an electrical signal proportional to the difference in the position of the rams or the error between them. This error signal is amplified by the servo amplifier which in turn strokes the control pump to provide an additional quantity of oil proportional to the position error, and in a direction to increase the speed of the ram that is lagging. In this way, the relative position of the rams under varying loads may be held to very close tolerances. ▼▼▼

What about performance of this pump servo control?

Accuracy—The electro-mechanical components will maintain an accuracy of ±1% under the following range of conditions:

Ambient temperature 130 F. to 150 F.
Line voltage 115 volts ±15%
Line frequency 60 cycles ±5%

Reliability—Vacuum-tube amplifiers have been replaced by magnetic amplifiers that have proved their reliability in field applications.

Shock and Vibration —The electrical components are essentially unaffected by vibration and shock encountered in industrial locations.

Safety Provisions —Two basic fail-safe features are included. The first one shuts down the equipment in the event of power failure; the second shuts down the equipment in case of a failure within the control system which causes the output to exceed its normal limits. In either case, the hydraulic pump slide block is automatically set to neutral and power is removed from the control circuits.

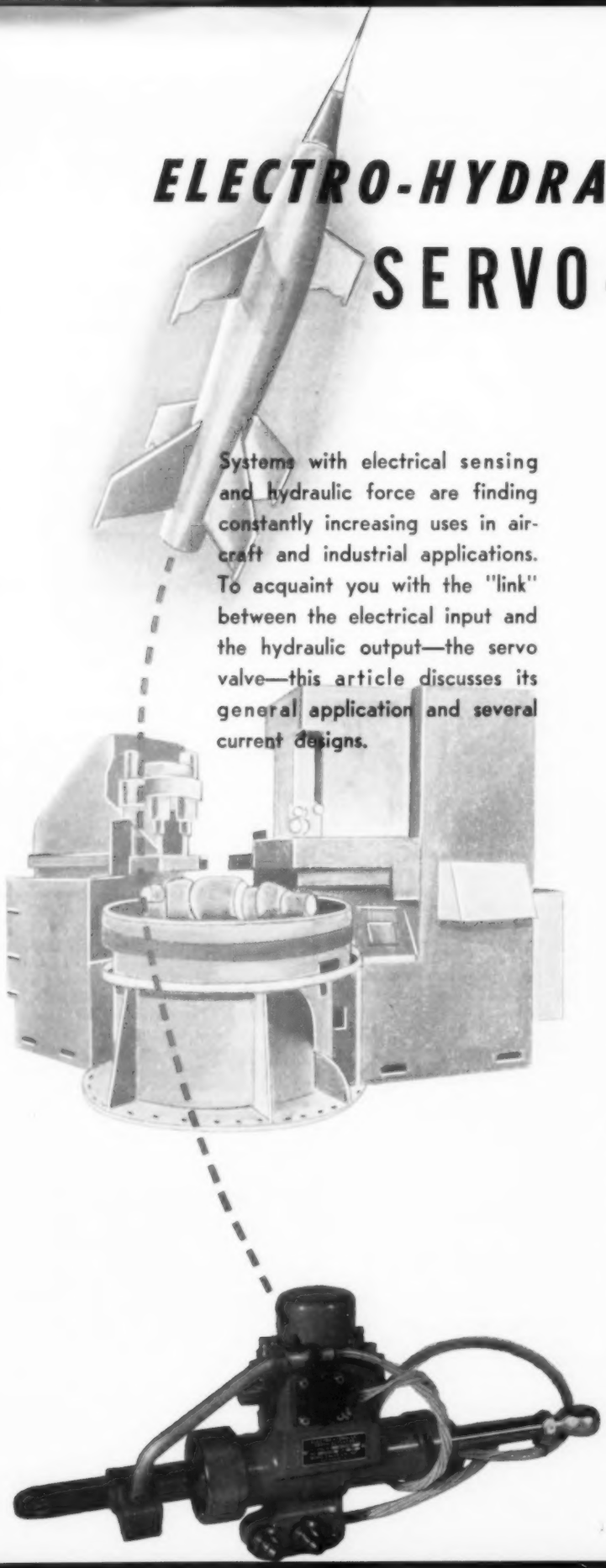
Power Consumption —Total power required by the system (exclusive of the electric drive motor for the hydraulic pump) is less than 100 watts.

Installation—Since the electrical connections may be made by any electrician, installation of electrical units can be accomplished conveniently and inexpensively. The pump control unit is part of the pump and requires no special installation.

Initial Adjustments—After initial setting, the servo amplifier gain and balance should not require further adjustment unless a basic function of the control is changed.

Maintenance—Little or no maintenance should be required during the life of the equipment. If the servo amplifier should fail, it can be readily replaced with a new amplifier. Only a-c connections have to be changed because there are no high-voltage power supplies.

ELECTRO-HYDRAULIC SERVO-VALVES



Systems with electrical sensing and hydraulic force are finding constantly increasing uses in aircraft and industrial applications. To acquaint you with the "link" between the electrical input and the hydraulic output—the servo valve—this article discusses its general application and several current designs.

SERVOMECHANISM is a very technical sounding term with a very simple meaning. Almost from the time a baby is born he learns the technique of error correction that is the essence of servomechanisms. As the child begins to walk he learns to change his course slightly with each step, so that the final result is walking in a (reasonably) straight line. Later in years as he drives his car down the highway using the center line as a guide, he is again acting to close the loop of a servomechanism by constantly turning the wheel to correct the error between the direction of his car and the line.

The basic servomechanism can be divided into an intelligence section which includes the control, error sensing, and amplifying functions; and the power output section which is controlled by the intelligence section. The initial control in a servomechanism which controls position is usually mechanical; but this mechanical motion can be transferred to either electrical or hydraulic control and the final mechanical output of the servomechanism may be either hydraulically or electrically powered.

Electro-hydraulic servomechanisms have certain advantages over completely electrical systems making them desirable for many aircraft and industrial applications. The speed at which a system can react to an input, expressed as a time constant or frequency response is one of the important characteristics of the system. This characteristic is dependent upon the inertia of the moving components including the servo components and the load. In electrical servomechanisms the inertia of the load is often only a small fraction of the total inertia which includes the motor actuator. To develop the required torque, the electrical motor must have sufficient windings to carry the current. This means a necessary mass which limits

the torque-to-inertia ratio of acceleration of the electric motor. The hydraulic actuator can be designed for a wide range of speeds and for straight-line or rotational motion so that gear trains are eliminated. Since the inertia of the hydraulic actuator plus that of the hydraulic fluid is not high, hydraulic power is particularly useful for fast operation. Maximum acceleration of an electric motor is about 45,000 radians per second per second, and this is for small, low-torque units. Accelerations for hydraulic motors range in the million of radians per second per second. Electrical actuators find their greatest applications for low-force applications in instruments and computers. Hydraulic actuators are generally used for high-force requirements in aviation and industry.

One factor which has limited hydraulic servomechanisms in the past was the complexity and awkwardness of the control system required. However developments in electrical control of hydraulic fluid now permit the flexibility and weight savings usually required. The unit which transfers this electrical control information into hydraulic power is the electro-hydraulic servo valve. The servo valve is a power amplifier as well as a transducer, because its low-level electrical input is in the order of watts or milliwatts, and its fluid power output controls an actuator which delivers power often in the order of several horsepower.

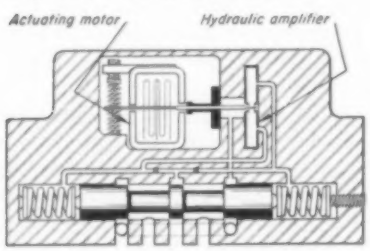
A basic hydraulic servomechanism consists of the following components:

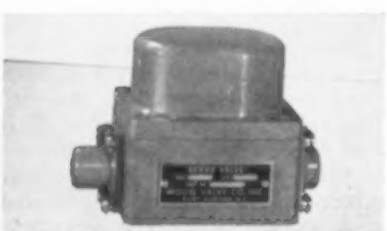
a. Controlling Device
b. Amplifier
c. Servo Valve
d. Actuator
e. Feedback Element

An input signal from the controlling device is amplified and applied to an electric torque motor in the servo valve. The torque motor positions a

FLAPPER-NOZZLE VALVE

Operation of this valve depends upon the control of end-chamber pressures which displace the main valve spool against high-stiffness centering springs. These end-chamber pressures are obtained by throttling the flow of fluid through differentially variable orifices in series with fixed orifices in the first stage. This flapper-nozzle type first stage is frictionless and capable of passing dirt particles up to .001 inches in size. It is constructed so that the mechanical stiffness of the flapper beam support is essentially cancelled by the effective negative spring rate of the permanent-magnet torque motor. By this means, a force balance is achieved between the pressure forces at the nozzles and the motor torque developed by a control current. Thus, when an input signal is applied, the flapper seeks a position which causes the pressure difference at the nozzles to be proportional to the input current. This same pressure difference appears across the main valve spool, resulting in a proportional valve opening. The flow required through the first stage is less than .1 gpm. This fluid is internally filtered by sintered bronze elements.





Courtesy Moog Valve Co. Inc.

This method of valve actuation results in high spool driving forces and minimizes spool friction and acceleration effects. The force-balance principle provides high frequency response.

Isolation of the electric motor from contact with the hydraulic fluid, eliminates the possibility of contamination of the motor by minute magnetic particles entrained in the fluid. This isolation is achieved by means of a flexure tube support for the flapper beam. This support can transmit motion by bending and has the ability to withstand very high back pressures without significant effect on valve performance.

This servo valve can control maximum flows from .5 to 8 gpm in systems from 500 to 4000 psi. The electrical input power required for full valve opening is approximately .07 watts.

Larger standard units for control of flows up to 100 gpm operate on the same principle, but utilize an intermediate power amplifying stage. Pressure control valves can be provided by replacing the main spool centering springs with auxiliary end chambers connected to the output pressure ports. ▼▼▼

INTERNAL PICK-OFF VALVE

This two-stage valve incorporates a valve-position pick-off which measures the position of the valve spool. This signal is fed back into the servo amplifier to close a loop around the servo valve. Thus flow through the valve to the load is made proportional to the signal to the torque motor. The two stages of the valve are a d-c torque motor operating a pilot valve, and a power valve and position pick-off. The valve has linear flow through square or rectangular metering ports, and lapped fits between hardened spool and sleeve. The valve lap can be accurately adjusted for optimum neutral position response. The maximum flow through the valve is 15 gpm, and maximum pressure is 3000 psi. Internal leakage is .1 to .2 gpm. The curves are typical for most servo valves. The frequency response curve was plotted by applying a variable frequency, sinusoidal signal to a servo amplifier driving the valve and then measuring valve spool displacement. Valve response is linear to 30 cycles per second, then the amplitude ratio increases to the natural frequency of 90 cycles per second. The "Phase" curve indicates that the sinusoidal output lags the input by 20 degrees at 50 cycles per second.

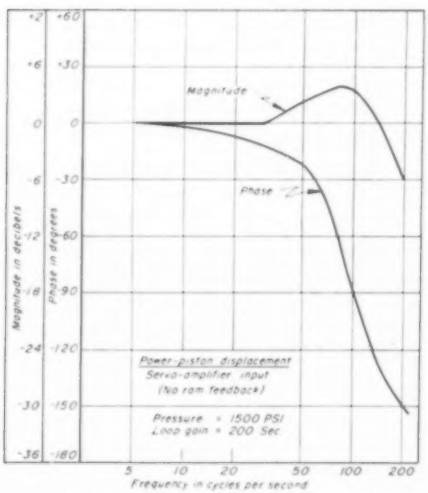
▼▼▼

valve spool to direct pressure fluid to the actuator which moves an aircraft control surface, a machine member, or whatever the controlled element may be. The feedback element is connected to the controlled element, so that it feeds back to the amplifier a signal according to the position of the controlled element. The control signal and the feedback signal have opposite polarity, so that when they are equal they cancel each other, and the system is in balance. Any movement of the controller or the controlled element unbalances the system so that it again moves to the required position.

VALVE DESIGN

Servo valves must be designed so that the spool is in static balance from the pressure at the ports. To meet this requirement there must be an annulus around each port or the ports must be opposed. With an annulus, the leakage path between ports is shortened. but this also tends to balance leakage forces. When leakage occurs between the spool and the sleeve, the pressure distribution on the spool is usually unsymmetrical and tends to push the spool to one side. This can be reduced by re-balancing the pressure distribution as often as possible by small circular grooves in the spool or sleeve. The pressure in the groove must be constant all around and therefore there will be a series of small unbalanced areas instead of one large one.

For a particular hydraulic servo design, the valve orifice area when fully open will usually be determined theoretically. However it is usual practice to allow a reasonable pressure drop through the valve when dealing with maximum flow rates, assuming that the maximum velocity and force demands do not occur at the same time. Valves of small diameter with long travels are rarely used since it is generally desirable to keep the valve motion to a minimum. This limits the error of the servo and the demands on the torque motor, though it may have disadvantages regard-

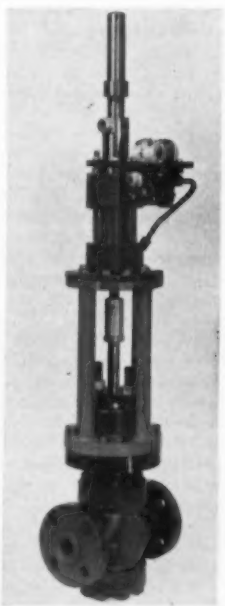


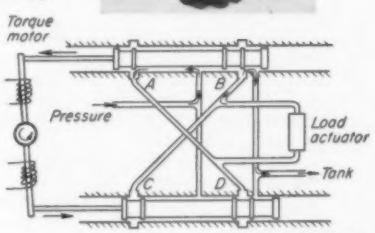
FREQUENCY RESPONSE OF THE SERVO-VALVE LOOP

Courtesy Hydraulic Controls Co.

SINGLE STAGE, PISTON VALVE

This single-stage servo valve, shown installed with the control for operating a large valve, is of the piston type. When the torque motor is actuated by a signal to move in the direction shown, fluid flows from the pressure source, through port A to the bottom of the actuator which may be either a cylinder or fluid motor. The drain from the top of the actuator is through port B to tank. When the torque motor is actuated in the opposite direction, flow is similar through ports C and D. This valve has no sleeve, and the valve body and piston are made from the same material to eliminate problems of differential expansion with a rise in temperature. By using a relatively high force torque motor to actuate the pistons directly, the valve is more capable of clearing itself in the event of clogging caused by foreign material. The working pressure for the valve is 200 to 3000 psi, and output ranges to about 4 gpm. Steady state leakage with no signal to the torque motor is .05 gpm. This type of valve is simply constructed and is reliable under shock and vibration conditions. The valve can be readily adjusted to change internal leakage, amount of lap, and valve characteristics. ▼▼▼





Courtesy Midwestern Instr.

ing friction. Generally, a valve diameter of two or three times the minimum theoretical diameter is selected to permit valve travel less than .05 inch.

The overall gain of the hydraulic servomechanism is the product of the hydraulic and electrical gains. In some cases it may be desirable to reduce the hydraulic gain and increase the electrical factor. This is done by reducing the size of the valve spool and increasing the travel. Most valve designs have annular ports in the sleeve and spool, or grooves in the valve spool and drilled holes in the valve sleeve. The drilled hole construction is of importance when using a valve with underlap, because the underlap orifices may consist of small drilled holes, and these may be easier than annular ports to position in manufacture. However they may produce a non-linear servo.

FLOW CHARACTERISTICS

In many applications the relationship between flow and valve displacement should not be linear. For instance on autopilot applications, other relationships may be better because of the large lags of the mechanical equipment at frequencies much lower than that of the servo. valve. There are various methods for obtaining special flow characteristics. The spool may be formed with tapers at the land edges, though these tend to trap dirt and may be difficult to manufacture. A hole pattern on the sleeve can be made easily, but at the expense of increased valve travel. Notching of the spool has also been used successfully.

VALVE OPERATING FORCES

Friction acting on the valve spool is particularly troublesome in servo valves because of the irregu-

Concluded on page 98

2-STAGE WITH INTERNAL NEEDLE VALVE

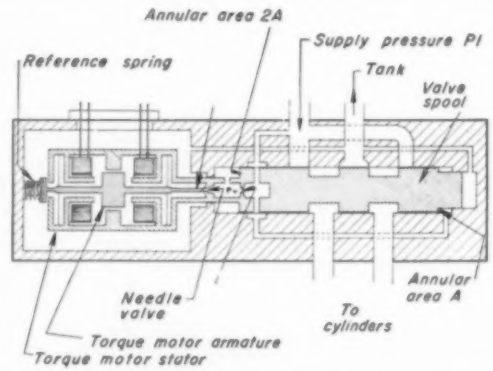
In the usual servo valve the stator of the force motor is attached to the valve case. This design requires that the motor armature travel a distance equal to the pilot piston. By decreasing the required travel of the motor armature, the motor size can be decreased, and the response of the servo valve can be increased. In this valve the stator of the motor is integral with the second stage valve spool and moves with it. The motor armature is free to slide against the spring pressure, and forms part of the needle valve which regulates pilot pressure in the valve. Displacement of the motor is ±.002 inches under dynamic operating conditions.

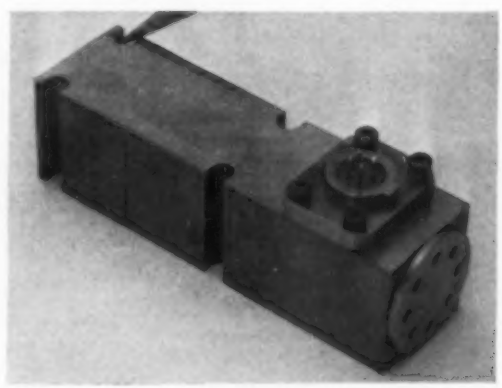
With zero or balanced input currents applied to the motor, the armature is in a neutral position so that the needle valve has an opening of about .001 inch. The fluid passing through the orifice creates a pressure Pv in the variable pressure chamber equal to one-half system pressure. This pressure acting on the annular area, 2A creates a force equal to the force developed by line pressure, P_L acting on annular area A, since area 2A is twice area A. When a differential current in the proper direction is applied to the force motor, the armature moves to the right until the electromagnetic force is balanced by the spring force. Since the reference spring is a linear device, the movement of the armature is a linear function of the input differential current. Movement of the armature to the right closes the needle valve and increases pressure in the variable pressure chamber. This increased pressure causes a force unbalance to move the spool to the right until the needle valve is metering oil at a rate such that P_v is again one-half of P_L and the valve spool is balanced. Applying a differential current in the opposite direction results in movement of the valve to the left in a similar manner.

The servo valve includes a non-jamming feature. If a chip should get caught in the valve spool, it is sheared off by the action of the high forces developed by the application of full system pressure to the second stage piston. Although a momentary chattering of the valve may result while the chip is being sheared, there will be no jamming. This non-jamming feature is designed as a reliability factor and not as a substitute for oil filtering.

The oil to the needle valve is filtered with a 2-micron sintered, stainless steel filter located internally in the valve, but accessible for change. The application of full line pressure to the valve piston, together with the internal hydraulic feedback principle and needle-type valve give a high hydraulic stiffness of control with an overall valve response approaching .003 seconds.

The use of the needle pilot valve and elimination of close-fitting metallic moving parts make dither unnecessary. There is no progressive build up of silt. An advantage of this valve is that the force motor always seeks a null position for all input signals, because the relative position between the motor armature and stator depends on the difference in forces on the valve spool. Linearity of output vs. input is maintained automatically as long as the flux density in the force motor is maintained below saturation. Maximum flow through this valve is 4 gpm and maximum pressure is 4000 psi. Other valves with similar design are available for flows to 400 gpm at system pressures to 4000 psi. ▼▼▼





Courtesy Sanders Associates, Inc.

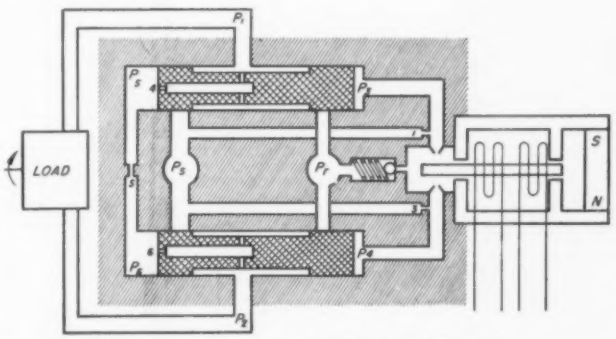
PRESSURE CONTROL VALVE

This pressure control servo valve provides a direct control of differential pressure across the ports of a hydraulic actuator which produces a force or torque output proportional to the electrical signal to the valve. The valve has a natural frequency of 150 cycles per second under no-load flow conditions and 3000 psi supply pressure. The differential pressure drop under load flow conditions is 20 to 30 psi per gpm.

The pilot stage of the valve consists of a torque motor whose displacement is proportional to the applied coil current. An extension of the armature lies between two nozzles which meter system fluid through supply orifices 1 and 3. Nozzle back pressures P_3 and P_4 are applied to the right end of each valve spool. The torque motor armature rotates to increase the restriction of one nozzle and reduce the restriction of the other. This action raises one nozzle back pressure and lowers the other. For zero current input these back pressures are equal and are about 40% of supply pressure.

Spool motion results from an unbalance of pressure forces. Restricting flow from the upper nozzle increases P_3 and moves the upper spool to the left. This opens the supply port P_s to the P_1 line. Assuming that orifice 5 is blocked, line pressure P_1 acts on the left end of the spool through the passage through the spool and orifice 4. When P_5 is equal to P_3 the spool stops. Under these conditions the spool acts as a repeater valve causing pressure P_1 to equal pressure P_5 because of the balance of forces. Any difference between P_1 and P_5 results in a force unbalance to move the spool and direct flow to line P_1 or P_R return. Flow in line P_1 can be increased or decreased with no static change in the line pressure except for flow forces acting on the spool. The operation of the slide valve controlling P_2 is identical to the above except that P_6 is the controlling pressure.

Now consider that orifice 5 is no longer blocked and pressure P_1 is greater than P_5. Fluid can now flow from P_1 to P_2 through orifices 4, 5, and 6. Because of the pressure drop across orifice 4, P_1 will be greater than P_5. Orifice 6 makes P_6 greater than P_2. For force balance P_5 must equal P_3 and P_6 must equal P_4. Therefore the differential pressure across the load ports (P_1—P_2) is greater than the differential back pressure at the nozzles (P_3—P_4). Proper selection of orifice sizes produces a pressure amplification, usually about 2, operating about the bias pressure or that gage pressure in the load lines when P_1 and P_2 are equal. By this scheme it is possible to obtain differential pressure at the load ports of plus and minus supply pressure while the nozzle drive differential pressure range is only plus and minus one-half supply pressure. It is impractical to operate the latter over a range much larger than this. ▼▼▼



Courtesy Cadillac Gage Co.

SERVO GLOSSARY

Amplitude Compensation—Method of linearizing valve performance by making torque motor force non-linear to compensate for reaction forces caused by flow of fluid through valve.

Amplitude Ratio—Ratio of valve output at zero frequency to output at a particular frequency when input signal is sinusoidal and of constant amplitude. Variation from ratio of 1:1 is expressed in db where:

$$1 \text{ db} = 20 \log_{10} \frac{\text{Ampl. measured freq.}}{\text{Ampl. zero freq.}}$$

Attenuation—Decrease of output of a servomechanism with increasing frequency of constant amplitude input.

Backlash—Angular play in a gear train.

Balance Current—Current in opposing coils at valve center or balance point. Also defined as input signal required to overcome valve unbalance and produce zero flow output.

Coulomb Friction—Constant magnitude combination of sliding and static friction assuming both are equal.

Displacement Sensitivity—Characteristic of spool motion in response to coil current. Also defined as torque motor armature displacement for a unit input current.

Dither—Vibration introduced into servo valve to overcome static friction or dirt silting.

Error—Difference between position required by input to servomechanism and actual position of controlled member.

Feedback—Principle of monitoring output position to adjust controlling input.

Frequency Response—Performance of a servo valve at various frequencies of sinusoidal input signal. Ratio of output to input is plotted against frequency.

Gain—Ratio of output to input.

Hunting—Action of improperly damped or unstable system in which actuator moves alternately to both sides of required position before coming to rest if at all.

Hysteresis—Difference in valve spool position for the same value of input current when this value is approached from opposite directions.

Linearity—Measure of deviation from proportional relationship in ratio of valve output to input. When output varies in direct proportion to the input the valve is considered linear.

Phase Lag—Time lag—usually expressed in degrees—between instantaneous position required by applied sinusoidal signal and actual position of valve. As frequency of signal increases, phase lag generally increases.

Sensitivity—Measure of ability of servo valve to react to an input signal. Ratio of full output to required input.

Stability—Characteristic of servomechanism which is properly damped and comes to final position without excessive hunting.

Static Error—Error of a servomechanism with a fixed applied signal, usually due to friction or load effects.

Time Constant—Elapsed time from application of step function input signal until valve reaches 63% of the required position.

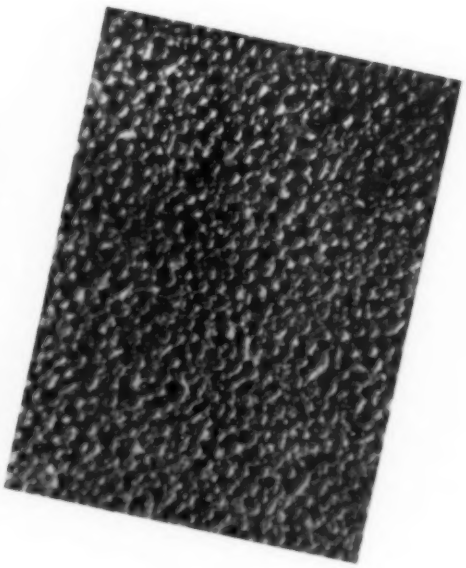
Torque-to-Inertia Ratio—Ratio of the applied torque at a given point in a rotational system to the equivalent angular moment of inertia at the same point.

Transducer—Device to change one form of energy to another. Torque motor is an electro-mechanical transducer. Feedback element is mechanical-electrical transducer.

Transfer Function—Functional relation between two variables such as input and output. Transfer function may also refer to relation between input and error.

Precision components in hydraulic servomechanisms require an extremely high degree of oil filtration. This can be accomplished with . . .

POROUS METAL FILTERS



● By Edward D. Kane

POROUS METAL ELEMENTS are available in a variety of configurations. Cell type (large element at left) has 2 sq ft of area and is used where conditions require a large area and the contaminant need not be back flushed for element cleaning. Cylindrical cartridge (large unit on right) has .6 sq ft of area and is used where area requirements are less and cleaning is desired by in-place back flushing.

HIGH PERFORMANCE servomechanisms require very fine filtration, and in some applications particles of less than 10 microns must be removed. In addition, the filter element must not discharge fibers into the fluid. Filters for aircraft applications must have a resistance to high temperature, corrosion, and the effects of certain additives used in high temperature fluids.

Servo valves with high response must function accurately with very small movement and low leakage. They are made to very close tolerances, frequently in the order of 40 to 60 millionths of an inch. Spool metering edges are subject to "silting" or collections of contaminates, and this silting can alter calibration of flows and jam moderate-torque servo valves. Fibers or pump wear parts—even though they are less than 1 micron in size—cannot be tolerated.

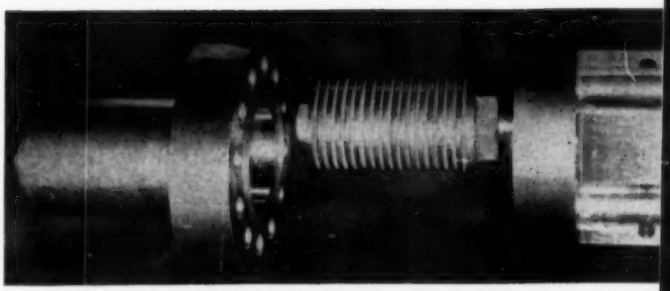
The high temperature requirements in aircraft are a result of the tremendous amount of skin friction at speeds of supersonic aircraft. This friction heats fluids flowing in tubing adjacent to the skin wall, and filters are presently being designed for operation in a temperature range of 300 F to over 600 F at line pressures to 5000 psi.

EDWARD D. KANE, *Manager Aircraft & Equipment Sales, Cuno Engineering Corp. Meriden, Conn.*

In order for hydraulic fluids to remain stable at these temperatures and not corrode any of the equipment, they must contain additives. These additives have certain effects on the phenolformaldehyde-impregnated pleated paper, or bronze, of a conventional filter.

Porous stainless steel elements have been developed to meet the requirements of finer filtration and higher temperatures. For temperatures to 350 degrees F, O-rings are used to seal the filter on a boss in the housing. For temperatures over 350 degrees, a threaded connection is used. This requires a special housing which is different from the MS specification 28720 which is now standard.

To accommodate higher flows of 18 and 24 gpm, the filter is designed with either a longer stack of cells or a larger diameter cell. On the present high-density aircraft, space is a problem and the filter must have sufficient area to ensure a reasonable life and still be within limitations of weight and initial pressure.



FILTER CONSTRUCTION consists of cap, filter element, and housing. Elements are fabricated from porous stainless steel, nickel, etc., available in various thicknesses, porosities, and physical properties. Powders are sintered in a special furnace and stock is inspected for pore size, pore size distribution, and particle size retention.

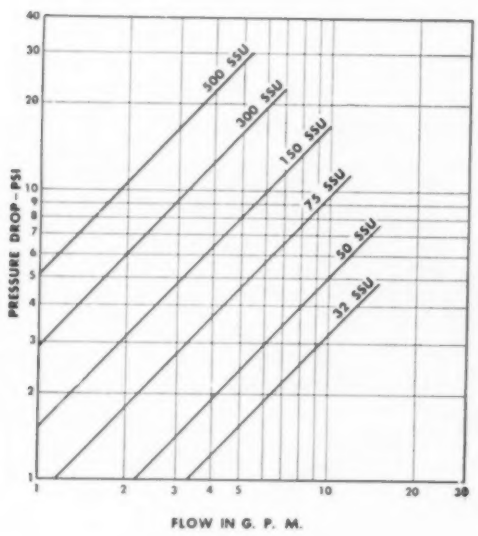
MAGNETIC FILTER

For removing sub-micronic particles, a porous filter element replaces the standard porous stainless steel element. This porous unit is made magnetic by the use of Alnico 5 ring magnets placed in the element. These elements are shrouded with a pure nickel, electrolytically forced screen which acts as a coarse magnetic strainer in the path of the fluid. The porous material is rated for 10-micron filtration to remove the non-magnetic contaminants such as bronze bearings, extruded O-ring stock, or bits of stainless steel tubing. The magnetic property of the porous material removes any submicronic iron particles. This porous magnetic filter is now being used in a guided missile autopilot. This unit under test is for a flow of ½ gpm, but more recent models have been designed for 3 and 8 gpm.

For special installations where the filter is incorporated as an integral part of a component such as a servo valve, molded units are made by a preforming technique. Very small cups of hat-shaped units can be made in this way. Some are now in use and some are on test with various valve manufacturers.

In a recent application a filter on an airborne installation was required to handle 8 gpm of MIL-O-5606 fluid at 275 degrees F under a pressure of 3000 psi. A magnetic filter element in an in-line housing with the relief valve is used for this application. The operating pressure drop of the filter is less than 20 psi and the cartridge portion is expendable. ▼▼▼

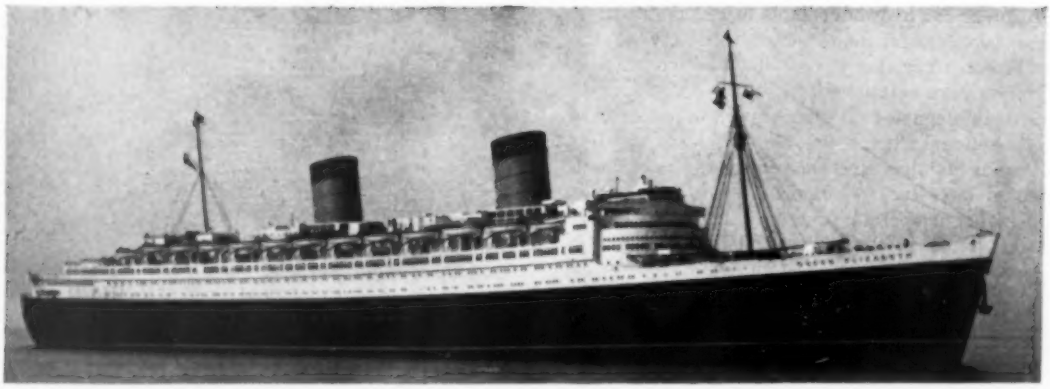
How to Select a Porous Metal Filter



The curves indicate the actual flow characteristics of a standard porous metal cartridge for filtration to 5 microns. Flow through a single cartridge is based on the contaminant concentration of the fluid and the required life of the filter. It is generally not desirable to exceed an initial pressure drop of 2 psi across the filter. Reading over from the 2-psi ordinate to the viscosity of the fluid in the system gives the maximum flow through the filter. The curves are approximate and are intended only for estimating.

Filters can be installed in one of these positions in a hydraulic circuit:

a. Suction line
b. High pressure line
c. Pump bypass
d. Relief valve discharge
e. Cylinder return line
f. Auxiliary or portable unit drawing oil from the main reservoir.

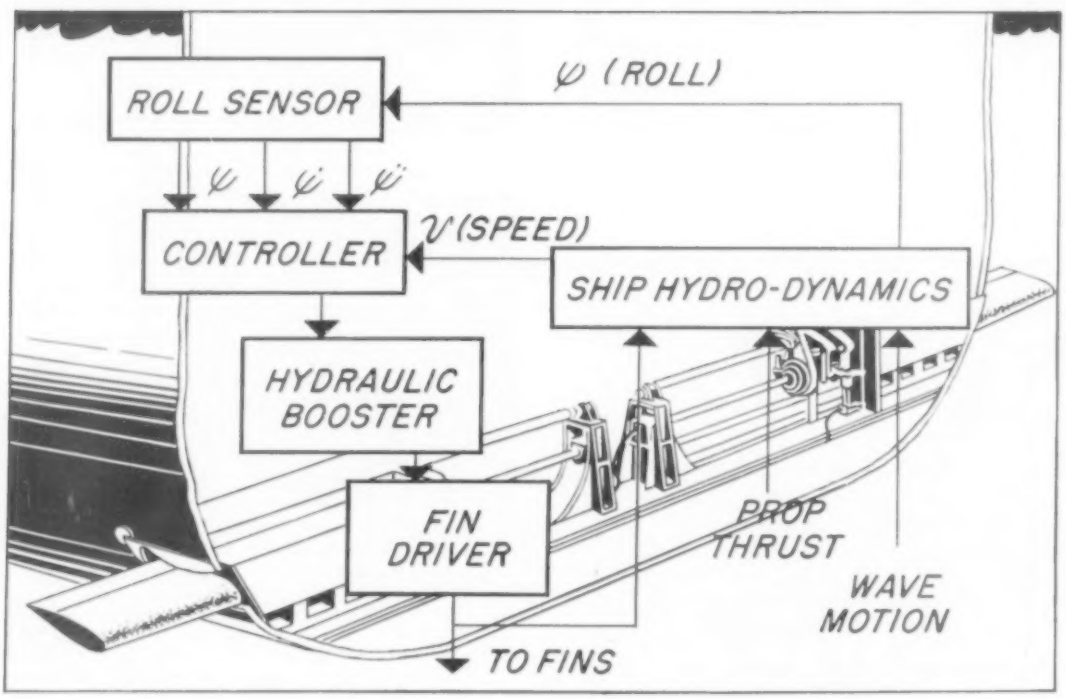


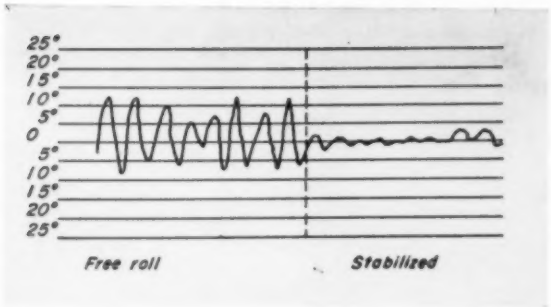
LINER QUEEN ELIZABETH has recently been fitted with stabilizer fins which reduce roll of 15 degrees to 2 degrees. Stabilizers reduce seasickness and breakage on passenger ships, and on cargo ships protect livestock, loaded freight cars and other cargo not stored for rough seas.

SERVO SYSTEM REDUCES SHIP ROLL

MARINE engineers have designed methods of correcting ship roll with such apparatus as water ballast, wing tanks, traversing weights, and giant gyro stablizers. A recent development of The Denny-Brown Ship Stablizer Corp. that has met with considerable success are hydrofoil fins which project from the ship's hull below the water line. The fins can be rotated to react with the water and produce stablizing forces. During calm weather or when the ship is in port the fins are retracted. They are extended in "heavy" weather.

Two small gyroscopes control the electro-hydraulic servo system which rotates the fins according

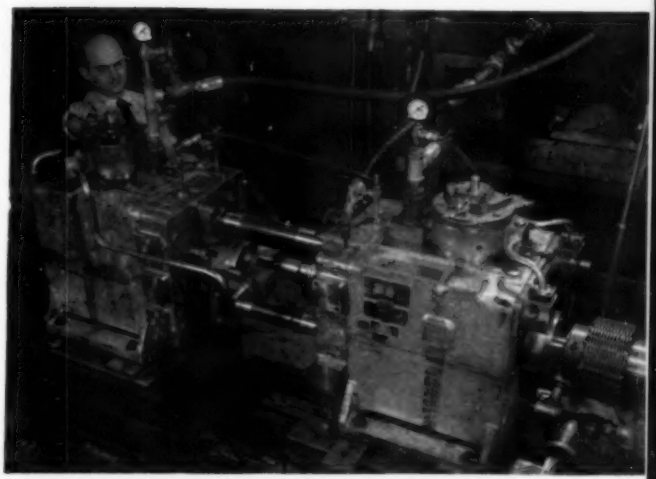




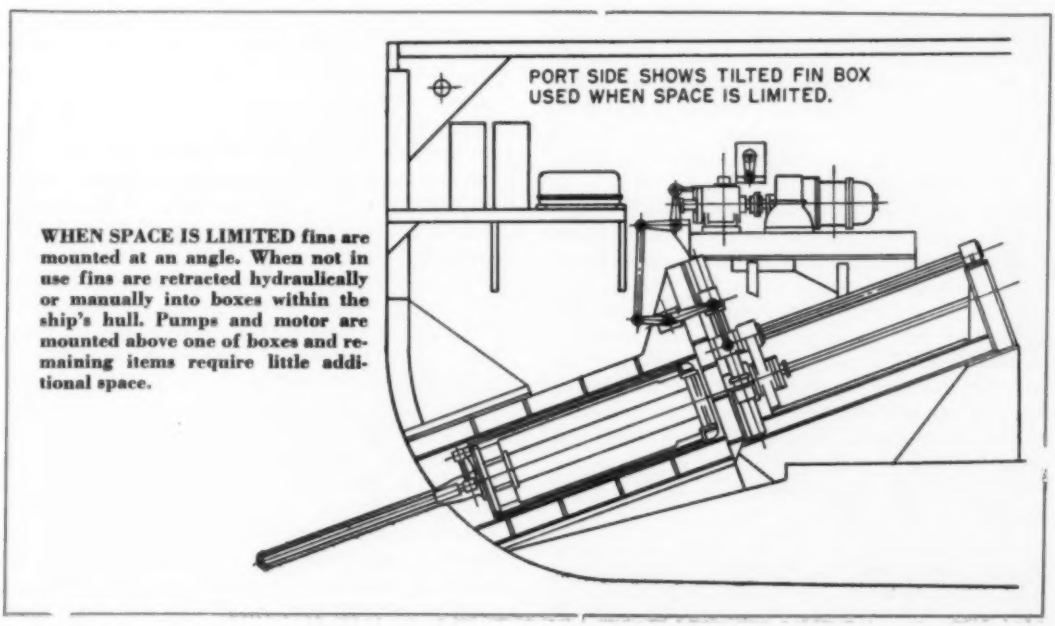
EFFECT OF STABILIZER on uniform rolling. A roll of 20 degrees has been nearly eliminated. This record was made with a sensitive accurate gyro roll recorder.

to the roll of the ship. One gyro reacts to any departure of the ship from vertical, and the other measures the angular velocity of the ship. As the ship takes a list, a small vertical gyro produces a signal which is transferred to the hydraulic valves to rotate the fins in the proper direction to right the ship. As the ship rolls, a second small gyro senses angular velocity and transmits a signal to set the fins to their full angle when angular velocity exceeds 2 degrees per second. At the end of the roll, the fins return to neutral and then reverse position for the beginning of the return roll.

Coordination of speed and direction of rotation of the fins is accomplished as the gyro signals are combined and amplified electrically and hydraulically through a series of servomechanims which control the main variable delivery hydraulic pumps. ▼▼▼



PUMPS FOR THE STABILIZER SYSTEM are of the axial piston, variable type. These function with a mechanical accumulator to supply oil to cylinders which are connected through levers to shafts on the fins. Complete reversal of the fin requires from 1 to 1½ seconds.



WHEN SPACE IS LIMITED fins are mounted at an angle. When not in use fins are retracted hydraulically or manually into boxes within the ship's hull. Pumps and motor are mounted above one of boxes and remaining items require little additional space.

Here are successful circuits used by Minnesota Mining and Manufacturing Co. to regulate speed and torque of hydraulically driven rolls. Their engineers are close to this control problem because their adhesive coated products are web materials. The trend of their operations is toward multiple, tandem operations. It has led to a search for . . . . . .

PNEUMATIC AND HYDRAULIC CONTROLS

. . . for fluid motor drives

● By Milton G. Malmquist

EXCELLENT hydraulic transmissions to power rotating rolls are available. The primary problem facing engineers selecting these drives is to develop suitable controls. The circuits on these pages show control techniques being applied to transmissions which consist of a fixed displacement motor driven by a variable displacement pump.

Here are some of the problems which these hydraulic drives must solve. Visualize two machines in tandem, with a web leaving the first machine at a fixed speed and going on to the second. Now consider the drive for this second machine. It must, at the very least, maintain a speed which is related to that of the first unit. If the total length of the web between machines is not critical, as in festooning, for example, the problem is relatively simple. Continuous error cannot be tolerated, of course, but large transient errors can be. The drive for this second unit can simply take some sort of speed signal from the first drive.

MILTON G. MALMQUIST, *Supervisor, Instrumentation Development, Minnesota Mining and Manufacturing Company, St. Paul, Minn.*

The problem is simply solved, also, when dealing with a strong web and high tension is permissible. Here a constant torque drive is provided for the second machine by controlling the pressure drop across the motor, maintaining a constant tension on the web and letting the web itself determine the speed of the unit. This drive will not do when there are several machines in the train, as the tension each drive puts into the web can be cumulative, eventually exceeding the limits of even a strong web. Also note that the torque of any motor is being absorbed in several places other than web tension, and it will be difficult to control tension to a low value when that tension, in terms of motor torque, is a small percentage of the total motor torque necessary to accelerate, overcome losses, and perform the operations the machine is to do.

Obviously, when many operations are combined the simple drives and controls rapidly become inadequate. What equipment can be provided for a train of machines handling a web which is soft and fragile at one point, strong at another, a web in which the amount of tension affects its quality and must be precisely controlled? This equipment must

VALVES

CONTROL OIL HYDRAULIC POWER

1/2"—20 gpm capacity, 3/4"—35 gpm capacity, 1"—60 gpm capacity—operating pressure up to 2000 psi non-restricted full flow parallel circuiting.

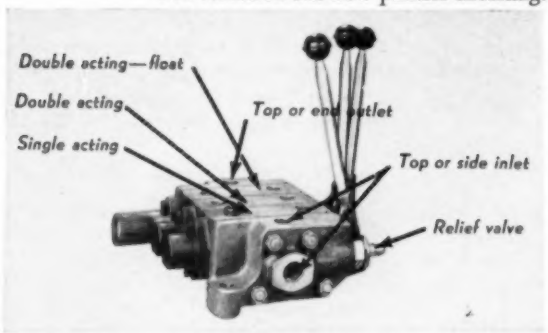


Fig. 3—Multiple directional control valve consisting of five manifold sections assembled into a unit. Any combination of operating manifolds, even up to a dozen or more, can be assembled into a single space saving unit.

MANIFOLD SECTIONS

INLET MANIFOLDS

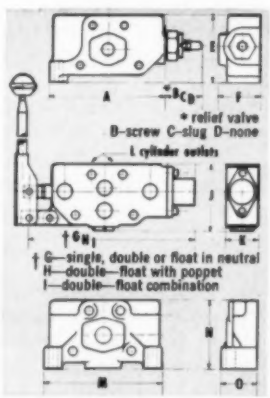
Side or top connections.
Screw or slug type relief valve, or without built-in relief valve.

OPERATING MANIFOLDS

Single acting, double acting, double acting float in neutral and double acting float in hold position.
Built-in positive hold check prevents load drop.

OUTLET MANIFOLDS

Tapped connections to provide for top or side return to tank, pressure beyond or direct bottom dump into tank.



APPROXIMATE OVERALL DIMENSIONS (IN.)

SIZE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
½"	7	2¼	1	⅛	4 1/16	2½	10	12 1/16	13	3⅞	2	½	7¼	4 1/16	2¼
¾"	8	2¼	1	⅛	4 ⅞	2¾	11 3/16	13 ⅜	14 3/16	4¾	2½	¾	8¼	4 ⅞	2⅝
1"	10	3	1¼	⅛	6 ½	3½	14	17 ¼	17 ¾	6¼	3	1	10½	6 ½	3¼

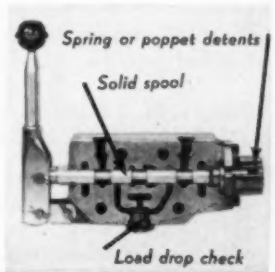
CHECK THESE FEATURES

FEATHER TOUCH OPERATION

Spools always in hydraulic balance provide extremely fine throttling for precision control.

NO LOAD DROP

Positive hold check built into every operating manifold section.



CYLINDERS

UTILIZE OIL HYDRAULIC POWER

single acting, double acting, telescopic capacity up to 25 tons—stroke up to 45 inches operating pressure up to 1500 psi.

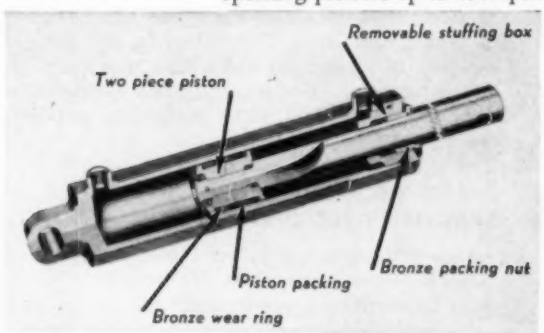


Fig. 4—Double acting solid plunger cylinder fitted with two piece piston. Disassembly for easy inspection and replacement of piston or stuffing box packings is a simple field operation. Note there is no metal to metal contact between piston and cylinder.

DOUBLE ACTING

ROD. DIAMETER		1	1¼	1¼	1½	1½	2	2	2½	2½
CYLINDER O.D.		2½	2⅞	3	3⅞	4⅞	5⅞	6⅞	8	9¼
DISPLACEMENT	PUSH	.014	.017	.021	.036	.061	.094	.133	.179	.242
	PULL	.010	.012	.016	.028	.054	.080	.119	.158	.220
EFFECTIVE AREA	PUSH	3.1	4.0	4.9	8.3	14.2	21.6	30.7	41.3	55.9
	PULL	2.4	2.7	3.7	6.5	12.4	18.5	27.5	36.3	50.9

SINGLE ACTING

PLUNGER DIA.	1	1½	1¾	2	2½	2¾	3¾	4¾	5¾	6¾	7⅞
CYLINDER O.D.	1⅞	2⅜	2⅝	2⅞	3½	3⅞	4⅞	5⅞	6⅞	8	9¼
DISPL'CM'T	.003	.008	.010	.014	.021	.026	.048	.077	.112	.155	.210
EFF. AREA	0.8	1.8	2.4	3.1	4.9	5.9	11.0	17.7	26.0	35.8	48.7

TELESCOPIC

2 SLEEVE

CYL. O.D.		4⅞	5⅞	6⅞	8	9¼
SLEEVE DIA.	1ST	3¾	4¾	5¾	6¾	7⅞
	2ND	2¾	3¾	4¾	5¾	6¾
DISPL'CM'T		.037	.062	.095	.133	.183

3 SLEEVE

CYL. O.D.		5⅞	6⅞	8	9¼
SLEEVE DIA.	1ST	4¾	5¾	6¾	7⅞
	2ND	3¾	4¾	5¾	6¾
	3RD	2¾	3¾	4¾	5¾
DISPL'CM'T		.050	.079	.115	.159

4 SLEEVE

CYL. O.D.		6⅞	8	9¼
SLEEVE DIA.	1ST	5¾	6¾	7⅞
	2ND	4¾	5¾	6¾
	3RD	3¾	4¾	5¾
	4TH	2¾	3¾	4¾
DISPL'CM'T		.066	.098	.139

5 SLEEVE

CYL. O.D.		8	9¼
SLEEVE DIA.	1ST	6¾	7⅞
	2ND	5¾	6¾
	3RD	4¾	5¾
	4TH	3¾	4¾
	5TH	2¾	3¾
DISPL'CM'T		.083	.121

Figures in tables shown in units as follows: diameter—inches, area—square inches capacity—pounds, pressure—lbs. per sq. in. displacement—gallons per inch of stroke

EFFECTIVE AREAS OF SLEEVES

SLEEVE DIAMETER	2¾	3¾	4¾	5¾	6¾	7⅞
EFFECTIVE AREA	5.9	11.0	17.7	26.0	35.8	48.7

Cylinder capacity, neglecting friction loss, can be approximated by multiplying rod, plunger or sleeve effective area by operating pressure.

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be automatic to eliminate the fallible hand and eye of human operators. This is not a hypothetical problem. It is a real one, and a short time ago there was no answer. The circuits in this article show some of the answers which have been put into operation.

SERIES TACHOMETER SYNCHRONIZED DRIVE

One of the first approaches Figure 1, used 1 hp variable delivery pumps as tachometers. One of these tachometers is mechanically driven by each

. . . . control of tension on stretchable as well as non-stretchable webs

machine drive. All tachometers are piped in series. The main drive pump of each downstream unit, or "slave", is the type in which the slide block is positioned by a hydraulic cylinder. This control cylinder is piped into the line between its own tachometer and the one upstream from it. If both tachometers are being driven so that they have the same rate of flow, the total volume of oil between the tachometers will remain constant and the piston in the control cylinder of the drive pump will remain stationary. If the slave drive should tend to slow down, its tachometer will slow down, decreasing its rate of flow below that of the upstream tachometer. The excess oil now being pumped by the upstream tachometer goes to move the piston of the drive pump control, speeding up the unit until both tachometers are again pumping at the same rate and the control piston is again stationary. Thus, the downstream unit always follows the speed of its upstream unit. Percentage speed differences, or "draw", between units can be adjusted by adjusting the displacement per revolution of individual tachometers.

Measurements of regulation error between two 3 hp units showed a maximum error under changing speeds at constant full load of 1.2%, and under changing load at constant speed of .25%.

This drive is satisfactory for soft, stretchable webs or where the web may be more or less festooned between units. It is limited to this kind of service for three reasons. First, during acceleration of the train of units, the control piston of the downstream units moves in, receiving oil from the tachometer line. This means that even though the downstream unit comes up to the same speed as the upstream unit, because the two tachometers must be pumping at the same rate of flow, it has lost a few absolute revolutions in getting there because the oil that went to move the control piston did not go through the downstream tachometer. Thus a web running through the two units will slacken on

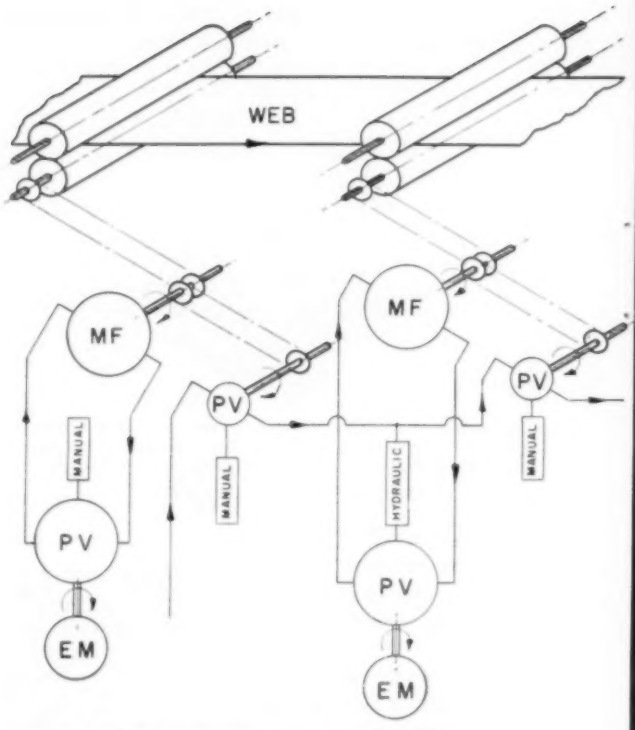

FIG. 1. Series tachometer synchronized drive

acceleration and tighten on deceleration. The length of web between the units will vary with the amount of oil in the control cylinder.

The second reason this drive is limited to stretchable or festooned webs is that a strong web can tend to over-drive the upstream unit. This may speed it up sufficiently to call for a speed up of the downstream unit. This in turn increases the tendency of the web to overdrive the upstream unit, and so on until control is lost and the whole train goes to maximum speed. It "runs away".

The third limitation is that the leakage losses in each tachometer are cumulative, all of them having to be made up, eventually, by the first unit. This limits the number of units that can successfully be installed in series.

PARALLEL TACHOMETER SYNCHRONIZED DRIVE

A hydraulic tachometer is driven from each machine drive, Figure 2, but instead of piping them all in series with each other, each is piped in series with its own master tachometer. All master tachometers are driven by one separate variable speed transmission which does nothing else. Draw between units is again adjusted by adjusting the displacement of individual tachometers.

This drive eliminates some of the difficulties of

the series-tachometer drive. It eliminates the slackening or tightening of the web on speed changes, because now the master transmission is the upstream unit, hydraulically speaking, for all machines. The same action occurs as before, but now it doesn't matter because the transmission is not connected with the web. It also eliminates the cascading of losses in the tachometers. Theoretically, any number of units can be installed in one train.

DANCER ROLL CONTROL

A dancer roll on the web is mechanically connected to the slide block of the downstream unit, Figure 3. In practice, the linkage usually operates the pilot of a hydraulic slide block positioning device.

In this case the tension of the web is constant, depending upon the weight on the dancer roll. However, control-wise it is a speed control because it is the volume output of the pump which is being controlled. There is a given position of the dancer roll for each web speed. These systems have the obvious disadvantage of the need for a dancer roll and the fact that it is mechanically connected to the pump. This loses the freedom of location of the pump.

The problem of installing a dancer roll can cause another limitation—instability of the system. For example, such a system was installed where space limitations made it impossible to get more than seven inches of travel on the dancer roll. When the

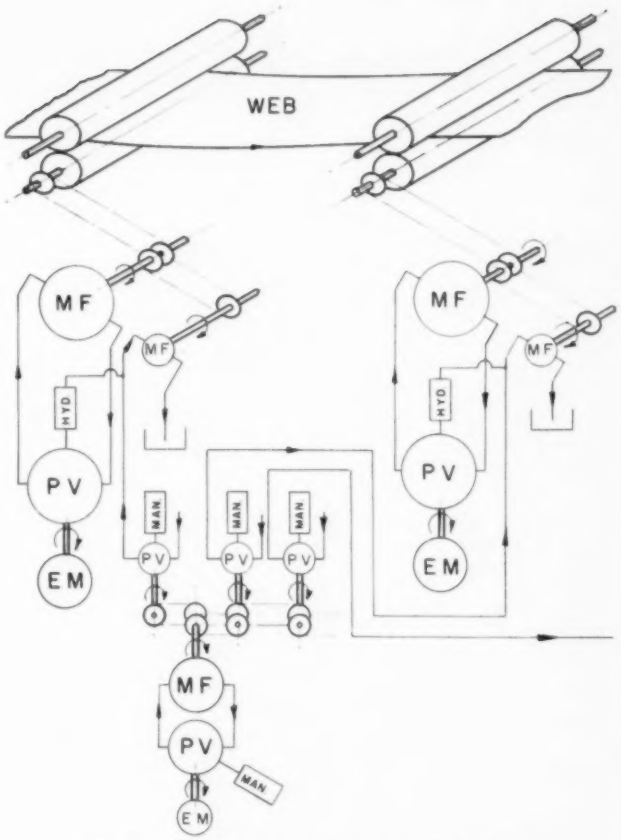

FIG. 2. Parallel tachometer synchronized drive

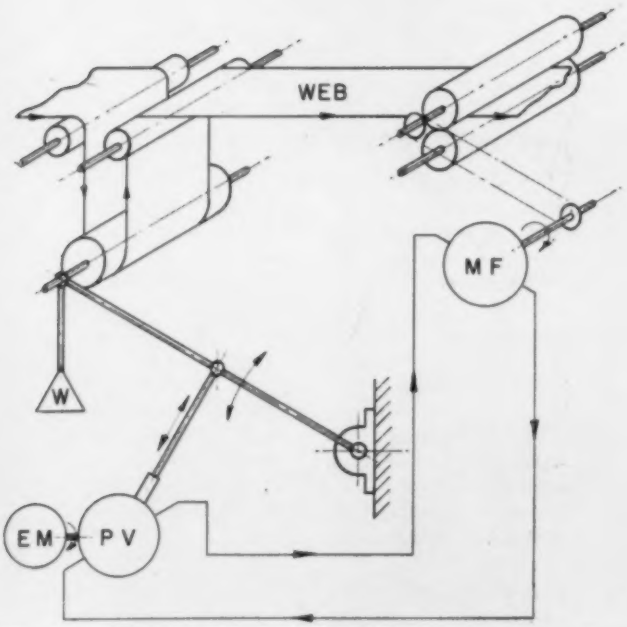

FIG. 3. Dancer roll control

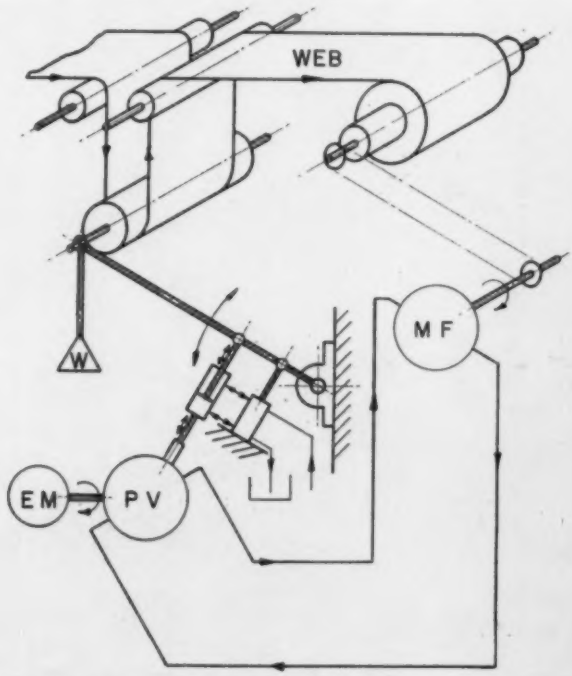

FIG. 4. Cylinder added to permit full speed range

system was tried, we found that it could not be stabilized until we reduced the ratio of slide block travel to dancer roll travel to 25% of its total. This of course limited the speed range of the equipment.

In order to keep this stable linkage proportionality and still use the full range of the equipment, we installed a hydraulic cylinder as the linkage to the slide block, Figure 4. A four-way valve, stroked by the dancer roll, valves oil to or from the cylinder, changing the length of the linkage. Thus, we keep the stable 25% proportionality; furthermore, a change in web speed or the change in winder rpm due to roll build-up will, when necessary, change the length of the linkage and thus reset the point about which the stable control operates. Now the pump is no longer proportional to the position of the dancer roll, but to the length of the linkage.

PNEUMATIC-HYDRAULIC COMBINATIONS

If pressure and volume of a pump can be controlled by a pneumatic signal, the wealth of available pneumatic instrumentation could be used to advantage. We have so far pneumatically instrumented hydraulic systems in four ways.

The first was to apply a pneumatic valve positioner and an air operated diaphragm or cylinder to control the position of the slide block. This was done in the same way that these instruments are used to control the stems of valves. The position of the slide block and therefore the volume of the pump is proportional to an air signal sent to the valve positioner. This system is used as a means of remotely setting machine speed where the equipment is installed in hazardous areas. An accurate instrument-type air regulator and gauge mounted on the operator's panel allows him to set the volume of a remotely placed pump. Pumps with pneumatic slide block positioning are now available commercially. On larger pumps the pneumatic system positions the pilot of a hydraulic slide block positioner.

Similarly, the valve positioner and air operator are used to replace the screw setting of an unloading valve. This allows remote setting of pressure for a torque drive.

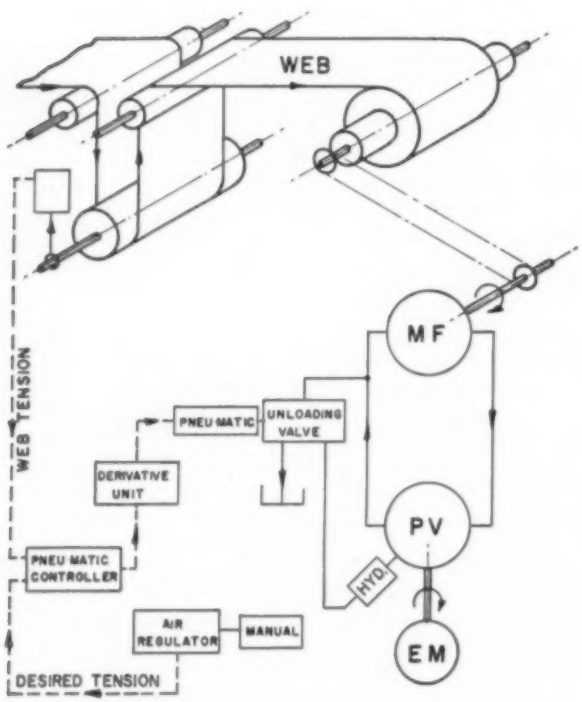

FIG. 5. Pneumatic-hydraulic combination.

UNLOADING VALVE IS SET PNEUMATICALLY

A constant tension winder using the pneumatically set unloading valve is shown in Figure 5. Web tension is sensed on a dancer roll. This measured tension is sent as a pressure signal to a pneumatic controller. Here it is compared with the desired value. The controller then sends on a pressure, through a derivative unit, to the pneumatically set unloading valve. The unloading valve sets the torque of the motor to achieve the desired tension.

The pneumatic controller has adjustable gain and adjustable reset, and the derivative unit adds a third degree of stability control to the pneumatic system. You will note the hydraulic system is still controlled by the unloading valve, with its fast response to transients. The slower response of the pneumatic portion of the system is still more than adequate to keep resetting the torque of the motor as the roll builds up and its radius changes.

TENSION IS CONVERTED TO AIR SIGNAL

The fourth application of pneumatic instrumentation is as an addition to the parallel type tachometer drive, Figure 2. Web tension is sensed between machines by a dancer roll which sends this tension in terms of an air signal to a pneumatic controller as in the previous example. The controller then adjusts the displacement of the tachometer, thus adjusting the speed of the downstream machine to bring the tension to the desired value. Hydraulically, of course, the system is still a synchronized speed control; the pneumatic system merely superimposes tension control onto the speed control, sensing any tendency to get out of step, and eliminating the possibility of runaways with the nonstretchable webs. ▼▼▼

This article was prepared from a paper delivered by Mr. Malmquist at the 11th National Conference on Industrial Hydraulics.

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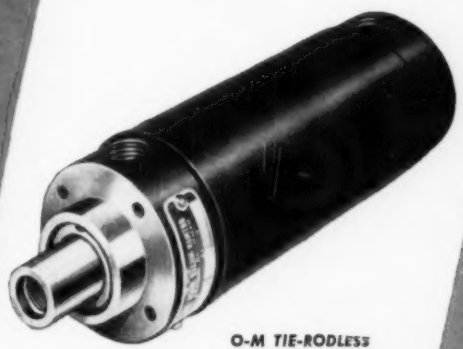

O-M TIE-RODLESS
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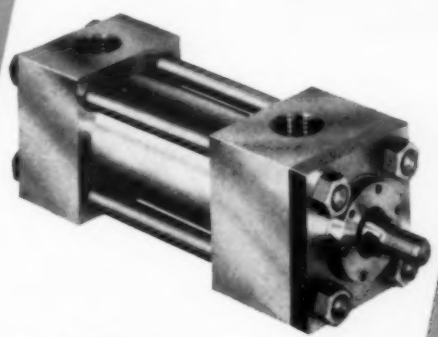

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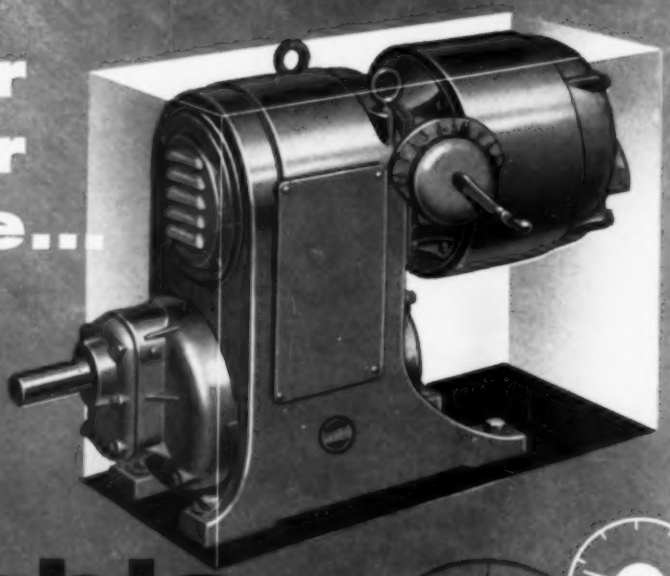

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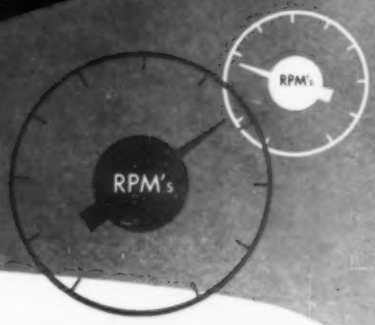

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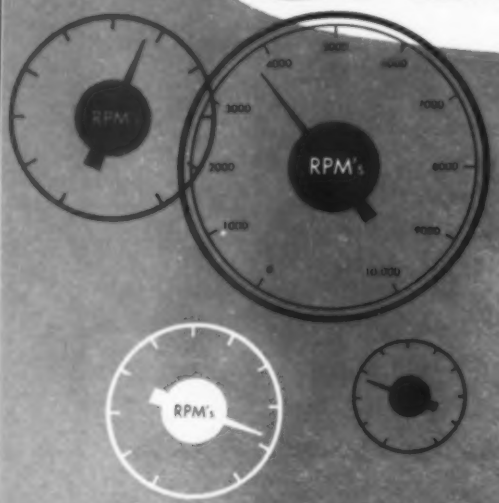

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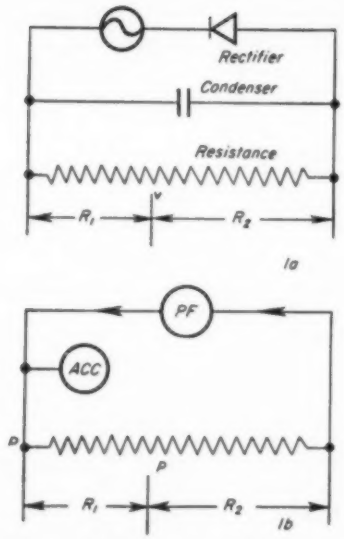


FIG. 1. A simple circuit illustrates the analogy between hydraulic and electrical systems.

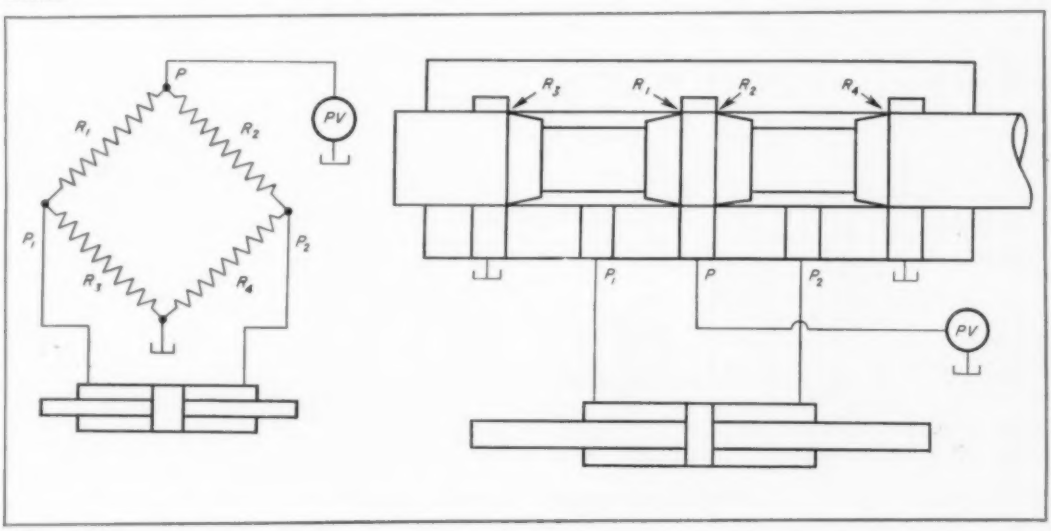
Electrical analogy in the study of hydraulic servo controlled machine tool tracers is an important design tool. Using this analogy, tracer devices are described as . . .

RESISTANCE TYPE SERVO CIRCUITS

• By J. R. Fawcett

SENSITIVE servomechanisms, such as those used for copying devices fitted to machine tools, usually employ some kind of hydraulic resistance. This kind of circuit gives very good sensitivity and accuracy because comparatively large changes in resistance can be caused by very small movements of the control. Accuracies of the order of .0005 to .001 inch are claimed by makers of hydraulic tracers using the resistance principle. About twenty years ago it was suggested that hydraulic circuits of this kind had much in common with electrical circuits and that many of the same principles apply. The development of new circuits is helped by analyzing them along electrical lines.

FIG. 2. Hydraulic tracer system is comparable to a Wheatstone bridge circuit.



RESISTANCE-TYPE SERVOS

For those who are not acquainted with this method, it should be explained that electrical units such as voltage and resistance can be compared with hydraulic units of pressure and resistance respectively, and a law, similar to Ohm's law, can be applied to hydraulic circuits.

Comparing the two simple circuits shown in Figure 1, we have in (1a) a rectified a.c. current passing through a resistance wire, and in (1b) the flow from a plunger pump passing through a pair of hydraulic resistances. In the electrical circuit a condenser has been fitted to damp out the a.c. ripple. Likewise in the hydraulic circuit the accumulator acts as a capacity to absorb the pressure ripple from the pump. The flow in the electrical circuit obeys Ohm's law: $I=E/R$. Flow in the hydraulic circuit obeys the equivalent equation: $Q=p/R$, where Q=rate of flow, p=pressure drop, and R=value of hydraulic resistance (assuming viscous flow). In the example shown:

$$p = \frac{P(R_2)}{R_1 + R_2},$$

and any change in R_1 or R_2 causes a variation in the intermediate pressure p.

The resistances, if fixed, take the form of jets, lengths of capillary tube or tapered needles. Variable resistances usually employ a plunger moving over a side hole or recess in the plunger barrel. By making the end of the plunger square or tapered, the amount the resistance changes for a given movement can be varied to suit the requirements. Too rapid a change may cause hunting.

One of the first circuits of this kind, devised by Cincinnati Milling Machine Company, has a hydraulic diagram very similar to the Wheatstone bridge Figure, 2. The valve is attached to the machine table with the plunger in contact with the template. The table moves in the same direction as the plunger as it follows the template contour, so that the plunger is kept as close as possible to the equilibrium position shown. In this position:

$$\frac{R_1}{R_3} = \frac{R_2}{R_4},$$

$$\text{and } p_1 = P\frac{R_3}{R_1 + R_3}, \text{ and } p_2 = P\frac{R_4}{R_2 + R_4}$$

Substituting for R_4

$$p_2 = P\frac{\frac{R_2 R_3}{R_1}}{\frac{R_2 + R_2 R_3}{R_1}} = P\frac{R_2}{R_1 + R_2} = p_1$$

Therefore in the center position, the piston will be stationary because the pressure on both sides is the same. Any slight movement of the plunger to the left will cause a large rise in resistance in

Concluded on page 90

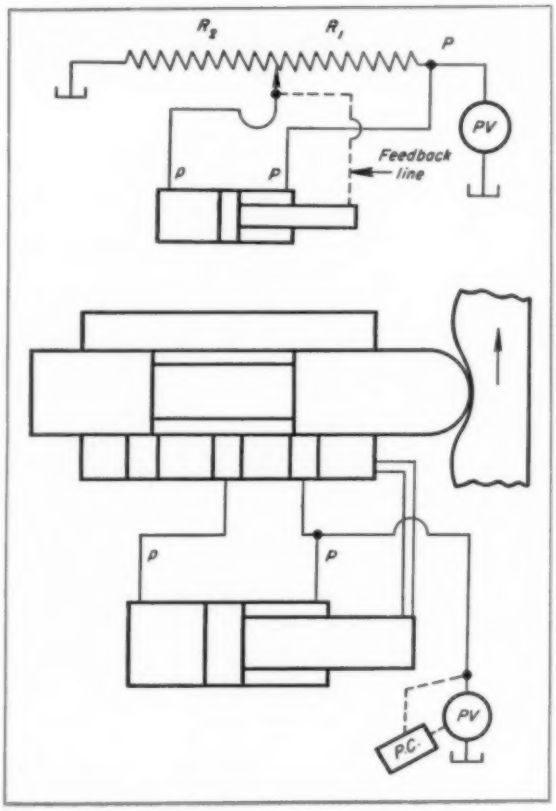


FIG. 3 For a single ended piston, a circuit based on the electrical potentiometer is practical.

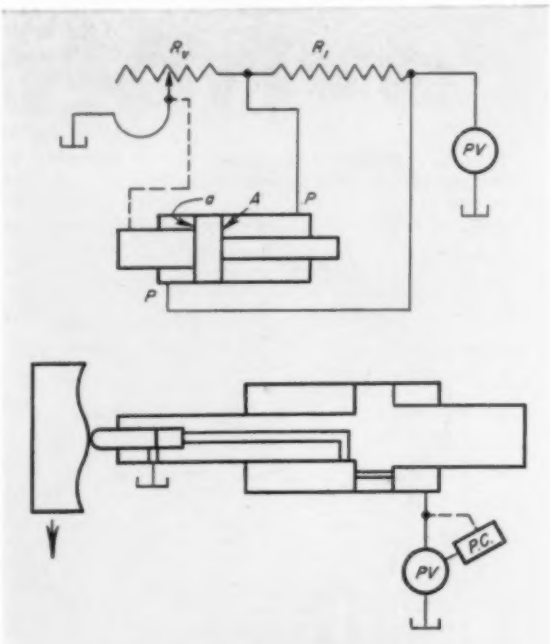


FIG. 4. One fixed resistance and one variable resistance controls the response of this tracer.

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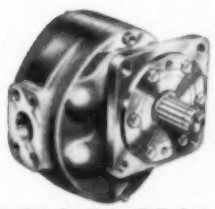

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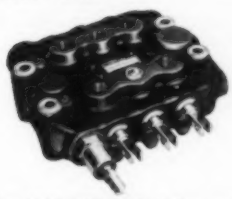

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RESISTANCE-TYPE SERVOS

Concluded from page 88

R_1 and R_4 and a reduction in resistance in R_2 and R_3 so that p_1 will fall and p_2 will rise. A movement of .001 inch is found in practice to produce a difference between p_1 and p_2 of about 60% of the applied pressure P. This method is intended mainly for double-ended piston actuation.

COMPARE TO ELECTRIC POTENTIOMETER

For single ended pistons, a circuit based on the electrical potentiometer is more suitable. The principle of this shown in Figure 3. If current flows along a resistance wire, the voltage drop varies with the ratio of the resistances either side of the tapping point. By taking the tapping from the center, the intermediate pressure is exactly half the applied pressure. The servo valve, which has only three ports and a simple grooved piston is attached to the machine table or slide. The plunger follows the template. Oil flows continuously from the pressure controlled pump through the valve to drain. In the equilibrium position, the resistance R_1 and R_2 are equal, and the pressure in the center of the valve is $p=P/2$. The piston has a rod half the cylinder area so that pump pressure P at the rod end, and half the pump pressure $p/2$ at the blank end balance. A 2:1 ratio is convenient, but the system would work equally well with other ratios. Any movement of the plunger will cause a shift in the R_1/R_2 ratio and a corresponding alteration in pressure "p" which will persist until the plunger is again restored to the equilibrium position.

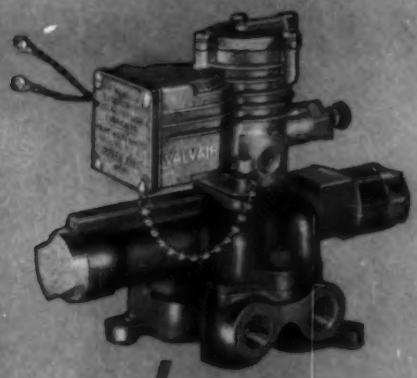
A third method employs one fixed resistance and one variable resistance. A practical application, Figure 4, uses a double ended piston with unequal rod diameter. Constant pressure from the pump is taken direct to the smaller area (a). Oil passes through a small hole which is the fixed resistance, and then through the rod itself to a variable resistance formed by a plunger moving over a hole. In the equilibrium position, the resistance R_V is adjusted by the plunger position so that:

$$P_a = pA,$$

$$\text{and } p = \frac{PR_v}{R_1 + R_v}$$

Any movement of the plunger will cause the piston to move in the same direction until equilibrium is again attained. The alteration of resistance R_V causes pressure p to rise or fall on area A so that the piston moves in the appropriate direction.

All these examples have one feature in common—the pump discharges continuously through the valve to drain and pressure is immediately available to provide the restoring force. This is an important factor in insuring rapid response when the template contour is irregular. ▼▼▼



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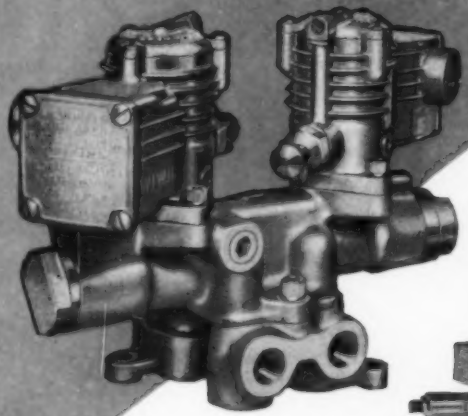

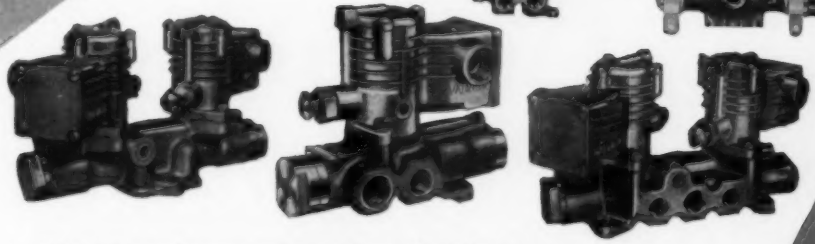

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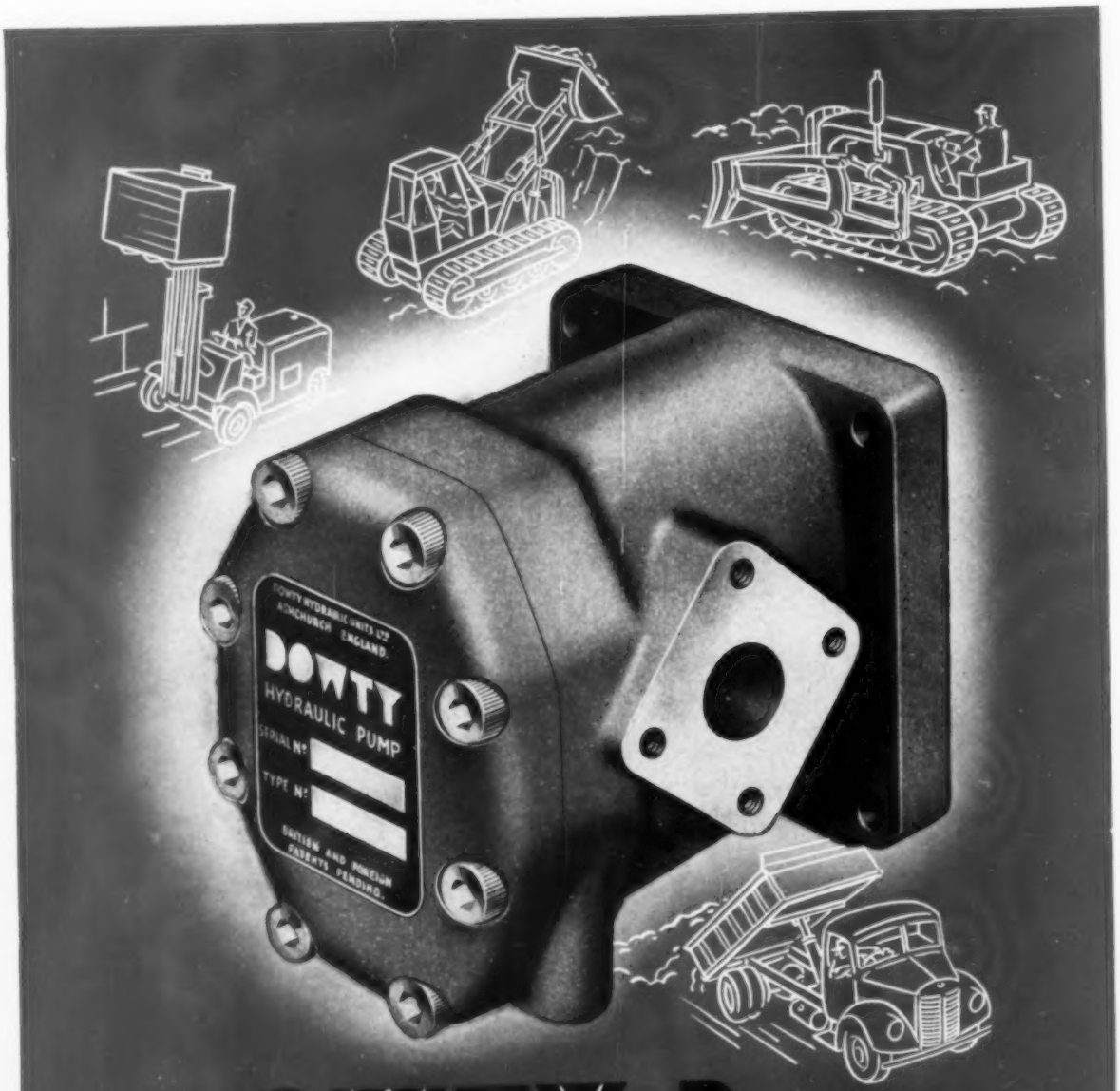

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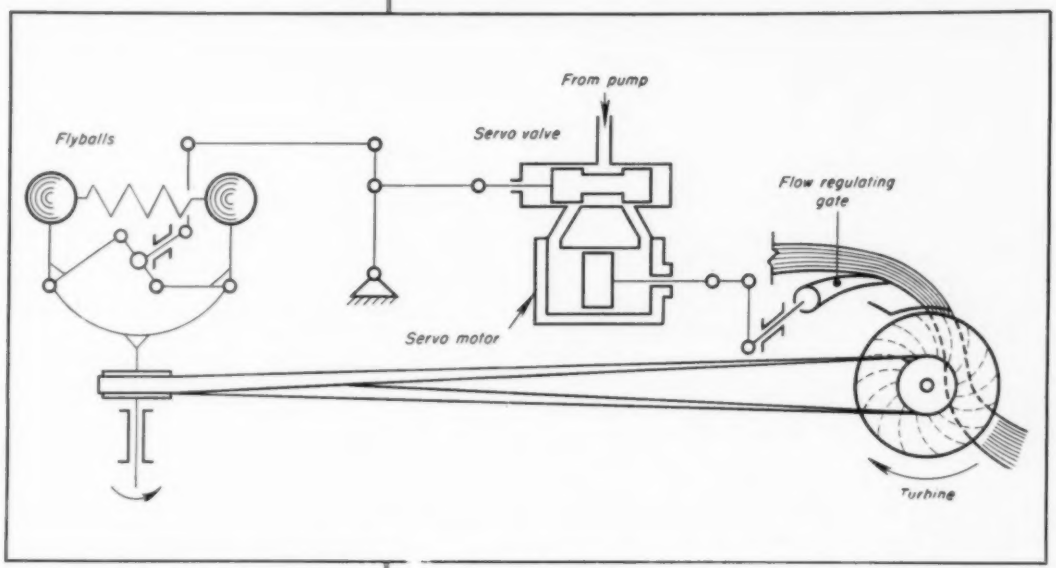

FIG. 1. SCHEMATIC of a hydraulic governor having no provision to prevent hunting.

MECHANICAL CONTROL OF SERVO VALVES

...to regulate prime mover speed

One of the oldest uses of oil pressure is for speed control of prime movers—water turbines and steam engines. Sensitivity and response of the "old fashion" oil hydraulic governor can be high. This governor provides a reliable answer to many control problems.

• By H. W. Hamm

BECAUSE many industrial controls are of the feedback type, and because the oldest use of oil pressure is in the field of speed control for prime movers, particularly water turbines, a description of this governing device can serve as a guide for many control problems. The control element to which the governor must respond, and the terminology may vary, but the principle is the same in a host of applications.

The nature of electric power supply and consumption for lighting, controls and power drives has the inherent feature of sudden load changes which in the case of a hydro-electric generator plant, result in variations of rotational speed of the water turbine and generator. Such speed changes cannot be tolerated as they cause flickering of the light, disturbance of radio reception and electric clock operation, and in certain industries, like the paper industry, result in an inferior product. For this

reason turbines are equipped with regulating valves or gates which admit a varying amount of water to the turbine runner in order to maintain a constant speed for varying power requirements.

The water valves or gates cannot be operated by hand because of the amount of power involved is too large, and also because adjustments must be so rapid and accurate even in the smallest units that manual control is impossible. A servomechanism and governor are required which automatically translate the torque, frequency and speed change into mechanical work for operating the turbine gates or valve. The governor consists of a detecting device which may be a set of flyballs, a hydraulic valve, or an electronic or electro-dynamic device, which is sensitive to speed changes and operates a servomechanism in the form of a hydraulic four-way valve. This valve admits oil to a hydraulic cylinder which in turn operates whatever closing device is provided for the hydraulic turbine. Direct mechanical linkage between the speed detector and the gates has been abandoned because friction forces cannot easily be overcome by delicate devices.

Essentially the same servomechanism is used for all types of prime movers. Water turbine governors differ from those for steam engines, gas and oil motors and steam turbines only in that the forces involved in moving the gates under water pressure are very much larger, and also sudden load changes with consequent changes in the flow of water cause pressure rise and drop, and cause water hammer. An automatic servomechanism must continuously and reliably accomplish speed control with the required sensitivity. It also protects the power house equipment and the attendants from harm caused by pipe line breaks, short circuits, bearing failure etc.

OIL HYDRAULIC GOVERNOR DESIGN

At the present time the oil hydraulic governor is used almost exclusively, and it has been developed to such an extent that it has become automatic, sensitive and reliable for this job. Figure 1 shows a hydraulic governor diagrammatically. Flyballs driven by gears or a belt from the turbine operate the hydraulic four-way valve to admit oil under pressure to the servo motor which operates the turbine gate, or any other flow regulating apparatus. An increase of speed causes oil to be admitted to one side of the servo motor and closes the gates; a decrease causes oil to be admitted to the other side to open the gates.

A governor as shown in Figure 1 could not be prevented from hunting. That is, the movement of the gates could not be stopped at the desired speed, but would overtravel, and the opposite motion would set in. This could be repeated indefinitely. For this reason a restoring or feedback mechanism

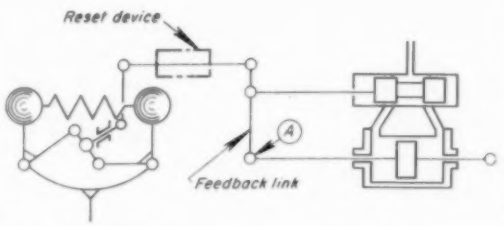

FIG. 2. FEEDBACK mechanism is added to prevent hunting, and a reset device is included.

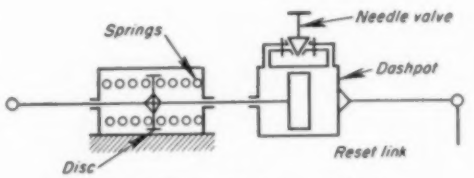

FIG. 3. DETAIL of the reset device.

has to be added, as shown in Figure 2. This restoring mechanism returns the four-way valve to the closed position and interrupts the oil pressure as soon as the servo motor piston moves. In this manner the gate movement is limited to the required amount. The piston rod or any other mechanical link connected to the gate of the turbine moves the floating feedback link in the opposite direction of the movement caused by the flyballs. In this manner the servo valve closes, stops the gate movement early, and hunting is prevented.

This governor is still not satisfactory because it does not provide for resetting the flyballs without affecting the already corrected speed. To prevent a speed change during reset, a dashpot mechanism is inserted in the restoring mechanism as shown in Figures 2 and 3. It effectively allows the flyballs to return to their normal position without causing movement of the servo valve.

This dashpot mechanism consists essentially of a small hydraulic cylinder filled with brake fluid. The cylinder is connected to the floating feedback link. Its piston is held in place by springs located in a spring housing which cannot move. This means that for the normal position of the dashpot cylinder and the closed position of servo valve, the flyballs must have a certain position and the unit a given speed. When this speed changes, the dashpot, moves like a rigid body. The incompressible fluid has too much viscosity to move from one side of the dashpot piston to the other in a short time through the needle valve. The spring mechanism is too weak to resist the force of dashpot piston. After

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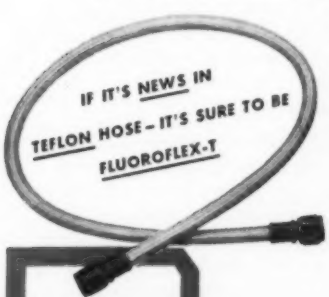

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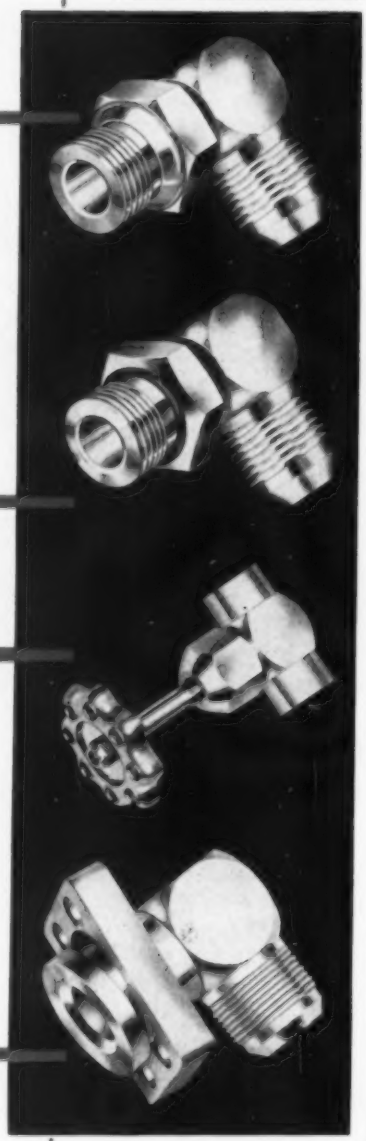
- Elbows and tees can be positioned.
- Bolt together and use as flange unions.



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MECHANICAL CONTROL OF SERVOS

the turbine gate adjustment has taken place, the disc which is acted on by spring pressure gradually returns to normal position with a speed regulated by the needle valve. In this way, normal given speed is resumed.

The governor can be provided with a hand regulating mechanism at point "A" of Figure 2. This

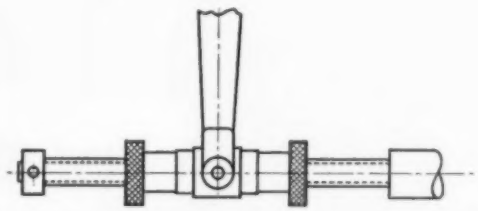

FIG. 4. DETAIL of regulating mechanism at point "A" in Figure 2.

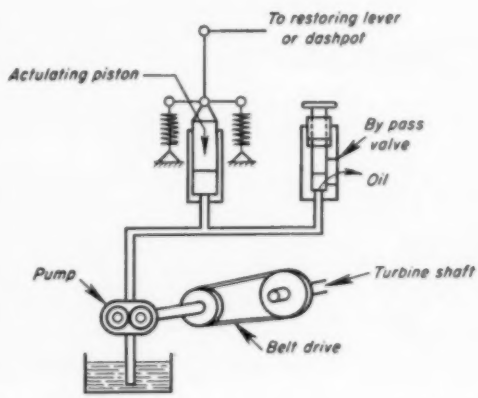

FIG. 5. SPEED range of the governor is increased by replacing the flyball mechanism with this oil operated actuator.

mechanism, Figure 4, serves to obtain different speeds for a given load or is used to adjust the speed to its normal value. It can also be used to obtain the same speed for different amounts of load, by changing the relationship between the gate servo motor piston and the flyball position for a desired speed.

The flyball mechanism of the hydraulic governor has a comparatively narrow speed range. If great flexibility and applications over a large range of speed is desired, a hydraulic rotary pump with a valve can take the place of the flyballs. This device, Figure 5, can be driven directly or by belt from the turbine shaft, or by a small synchronous motor which receives its current from the turbine generator. The pump is driven from the turbine either directly or indirectly. It exerts pressure on the actuating piston which at normal speed is held in

Photo shows hairline contact of LPD Clipper Seal which provides negligible torque when seal is tested on dry run of torque measuring apparatus.

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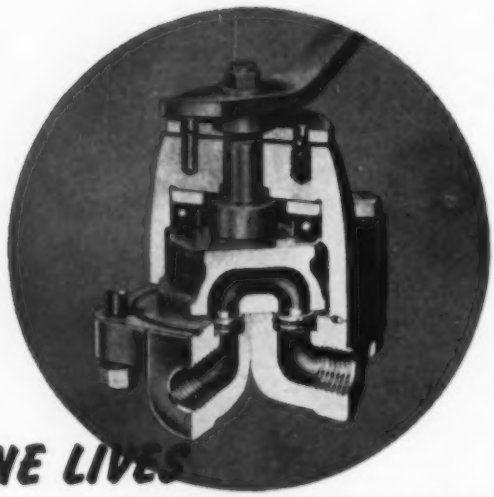

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to provide unmatched control of oil hydraulic cylinders, presses and motors	Excellent throttling	Smooth action to any degree of flow without fighting the fluid pressure
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We'll be glad to refer to you similar examples in your own vicinity. To get complete data on Shut-off, 4-Way and Dual pressure Valves for oil pressures to 1500, 3000 and 6000 P.S.I. ask for bulletins 0-5 and 5-DP.

BARKSDALE VALVES

5125 Alcoa Avenue, Los Angeles 58, California

MECHANICAL CONTROL OF SERVOS

position by springs. The bypass valve is adjustable to give the desired pressure and discharge to maintain normal position of the actuating piston at the correct speed. When the speed of the turbine changes due to load rise or drop, pump pressure also decreases or increases. Pressure change causes movement of the actuating piston. The piston motion can be used in the same manner as that of the flyballs to operate the four-way valve of a hydraulic governor.

There are many sensitive control devices of this type available which are often only applied in limited fields. Some of them deserve recognition and application in other fields because of their reliability and cost. ▼▼▼

ELECTRO-HYDRAULIC SERVO VALVES

Concluded from page 75

lar character of the friction. The collection of small particles of dirt or silt which accumulate in the narrow annulus between the valve elements can eventually cause a complete blocking of the passage and increased friction. Micronic filtering may not be the complete answer to this problem. Dirt which has small enough particle size to pass through the filter may be developed by the valve itself, and dirt may be trapped between the valve and the filter during assembly. One means of minimizing the effects of friction and dirt is to introduce a dither or vibrating motion to the valve. This can be avoided in some designs, but its use is justified on extremely sensitive servos.

SERVO VALVE PERFORMANCE

Two important characteristics of a servomechanism are stability and frequency response. These can be determined by applying an electrical signal to the system and analyzing the output by means of an oscilloscope. This will indicate whether the system reaches the position required by the signal within a permissible number of oscillations.

To determine the frequency response, a sinusoidal signal is applied to the input and the output is observed. Phase lag and distortion can easily be determined by this method. To compensate for phase lag in the hydraulic section of the system, a phase advancing network may be designed into the electronic section of the system. Another means of improving performance is to make use of anticipation or derivative control, where the output is responsive to the rate of change of error as well as the error itself. This is easily accomplished electrically but not hydraulically. ▼▼▼

Pumping Progress Report

FOR MECHANICAL ENGINEERS

An advertisement prepared by the Aldrich Pump Co., Member of Hydraulic Institute, U.S.A.

PROVIDING SMALL VOLUMES OF HYDRAULIC POWER at low, medium or high pressures is a problem frequently encountered by hydraulic engineers. Often, in the past, this was economically infeasible. Not so today, however.

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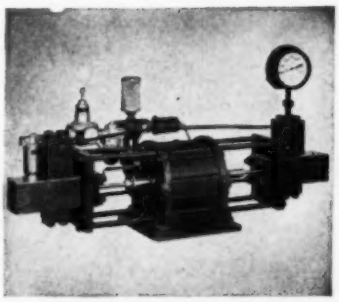
INSTALLATION of air-operated hydraulic pumps is simple. The air cylinder is bolted to a foundation, and pump suction, pump discharge and air inlet lines are connected. The units occupy a minimum of space; the air cylinder base is only 12½-in. x 14-in.

COMPLETE DETAILS of the ALDRICH Air-driven Hydraulic Pump are described and pictured in Data Sheet 36, which will be sent at your request.

Address: The Aldrich Pump Company, 14 Gordon Street, Allentown, Pa.



Aldrich Air-driven Hydraulic Pump

. . . for your tough pumping problems specify ALDRICH

One of the many tough pumping problems frequently faced by Aldrich engineers is that of supplying small volumes of hydraulic power at low, medium or high pressures.

In answer to this problem, Aldrich developed the completely self-contained Aldrich Air-driven Hydraulic Pump. Operating from a plant's normal compressed air supply, it can produce hydraulic pressure up to 23,700 psi, making it ideal for production or laboratory use.

Typical Applications for Aldrich Air-driven Hydraulic Pumps:

Testing: Tubes, Valves, Pressure vessels
Providing power for: Die casting, Plastic molding, Belt presses

Write today for Data Sheet 36 describing the Air-driven Hydraulic Pump.

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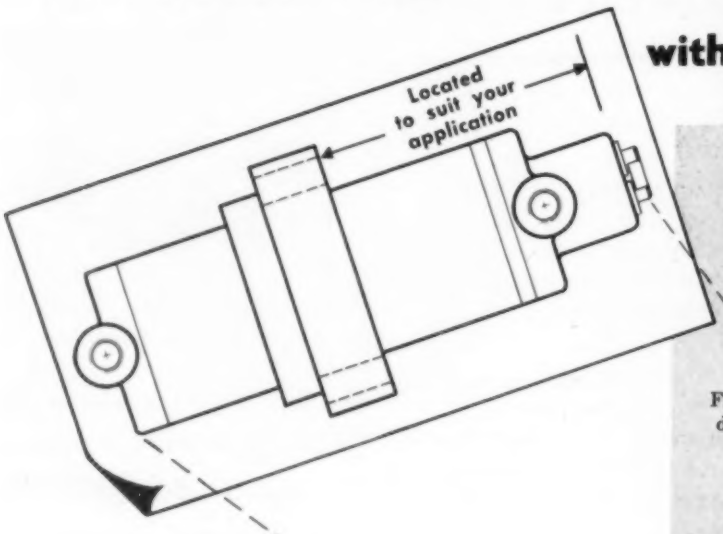
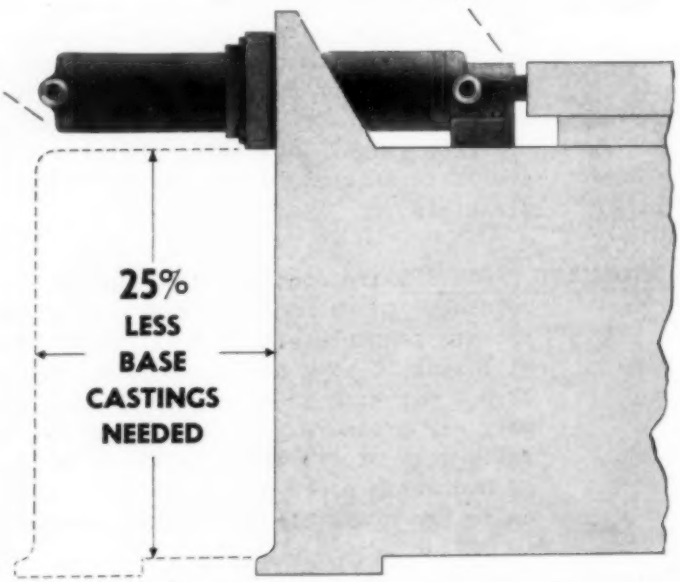
with **Pathon INTERMEDIATE FLANGE MOUNTING HYDRAULIC CYLINDERS**



Application of the Pathon Intermediate Flange Mounting, as shown by the simplified drawing below, saved this machine company 25% of their base casting cost. Bonus advantages included reduced shipping weight, easier handling, and the universally recognized operating efficiency inherent in all Pathon Cylinders.

With Pathon Intermediate Flange Mounting Cylinders you choose whichever mounting position best suits your specific needs. Various heads of other mounting types may be combined with the intermediate flange to provide a large number of combination mountings. Thus special mounting brackets are eliminated. The cylinder is rotatable to any position for connecting pipe ports and mounting puds. Pathon Cylinders are available in the R. H. 2000 P.S.I. Series and the Q.H. 1000 P.S.I. Series.



HAVE YOU A HYDRAULIC CYLINDER MOUNTING PROBLEM?

The chances are that one of the standard eight Pathon Hydraulic Cylinder mounting types or their combinations will adequately fill it. However, on any unusual Cylinder problem, we will be glad to help you reach a solution. Don't hesitate to write us.

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AIR CYLINDERS—HYDRAULIC DIRECTIONAL CONTROL VALVES—HYDRAULIC CYLINDERS

PUMP CONTROL SERVO

for ship steering gear

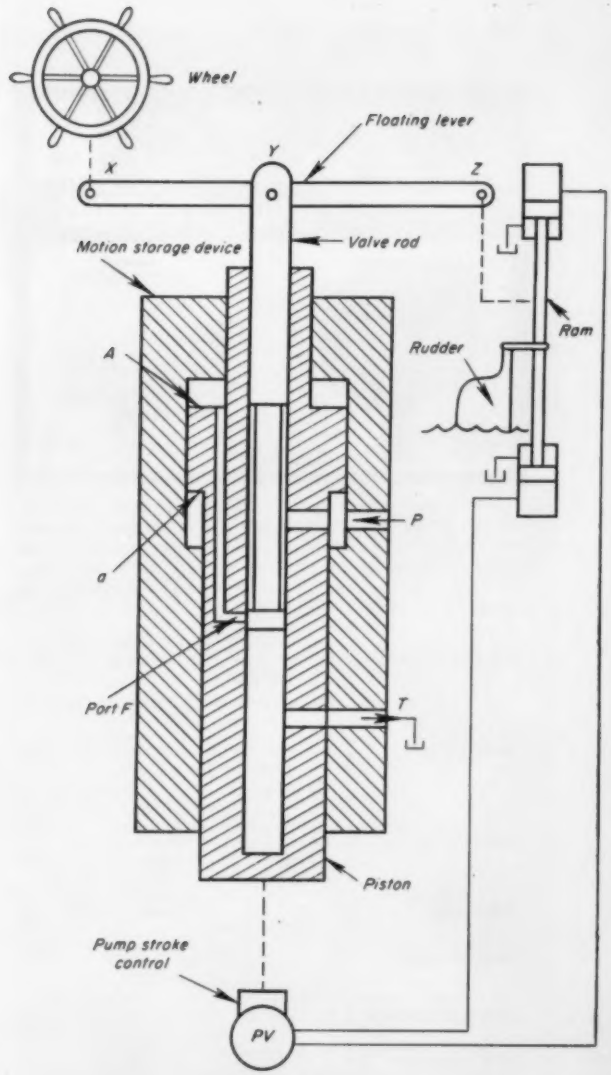
• By R. C. Lamond and V. A. Olson

ELECTRO-HYDRAULIC steering gears for marine applications have been used on all classes of ships since the first application on the battleship New Mexico in 1917. The equipment consists essentially of a ram and cylinders driving the tiller or rudder crosshead of the ship. Power is generated by a variable delivery, reversible radial piston pump driven by an electric motor. The stroke of the pump is controlled by a differential device, and pump delivery and movement of the rudder depend upon the relative positions of the wheel and the rudder. When the helmsman turns the wheel, he changes the stroke of the pump for a corresponding position of the rudder. A follow-up motion from the rudder back to the pump stroke control puts the pump in neutral or no-delivery position when the rudder reaches the position required by the motion of the steering wheel.

In addition, a motion storage device is required, so that when the wheel is turned at a rate faster than the rudder can react, the motion of the wheel is "stored" until the rudder can reach the required position. The storage motion device also prevents jamming of the control in the event the rudder should strike an obstruction. Until recently this control was accomplished mechanically with cams, but a compact hydraulic unit developed by American Engineering Co. is now replacing the complex and costly cam mechanism.

This motion storage servo device consists of a sliding piston which is connected to the stroke control of the variable displacement pump, and a valve rod which slides in the piston. The valve rod is connected to a floating lever, one end of which is connected to the steering wheel controlled by the helmsman, and the other end of which is connected to the ram actuating the rudder and furnishing the follow-up. This floating lever acts as a differential to position the valve rod of the motion storage servo device. This in turn positions the piston and the pump stroke control.

R. C. LAMOND, V. A. OLSON, *Marine Div., American Engineering Co., Philadelphia, Pa.*



MOTION STORAGE DEVICE connects wheel and rudder to pump stroke control. When wheel is turned faster than rudder can react, motion is stored between valve rod and piston until piston reaches position to close port F.

HOW IT WORKS

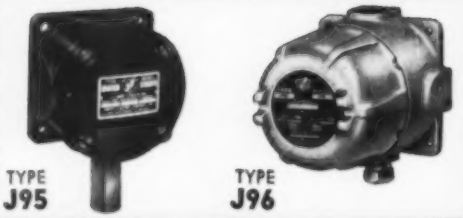
Constant pressure from an auxiliary pump is applied to port *P* and acts against area *a* of the piston. When the valve rod is in the position shown, port *F* is closed preventing flow from the area *A* side of the piston to tank. The piston and pump are in neutral position, so that no fluid is delivered from

the pump to the rudder-positioning cylinders. Turning the wheel in one direction moves point *X* of the floating lever up. Point *Y* also moves up as the floating lever initially pivots about point *Z*. This moves the valve rod up uncovering port *F* and permitting fluid from the area *A* side of the piston to drain to tank. The piston moves up because of the pressure applied to area *a*, and the pump stroke control is positioned for the required delivery to the respective cylinder. The piston continues to move up until port *F* is again closed.

The pump is now being held on working stroke and the rudder is in motion. As the rudder moves, the followup from the ram causes point *Z* to pivot about point *Y* when the rudder and the steering wheel are moving at the same rate. When the wheel is stopped, point *X* of the floating level is held stationary and acts as the pivot point. The follow-up from the ram now causes point *Z* and point *Y* of the floating lever to move down as the lever pivots about point *X*. This moves the valve rod down and uncovers port *F* permitting flow of pressure fluid to area *A* as well as area *a* of the piston. Because of the difference in areas, the piston moves down until port *F* is again closed, and re-positions the pump back to neutral at the new position of the wheel and rudder. Turning the wheel to the left initiates the opposite sequence of actions. ▼▼▼

HAZARDOUS CONDITIONS? J95 / J96

Use UE Explosion Proof PRESSURE-VACUUM CONTROLS



The Types J95 and J96 Pressure-Vacuum Controls are designed for applications in hazardous locations where explosive vapors or gases are present and close on-off differential control is required. In both units, pressure settings are uncalibrated and adjustment is made by an internal nut.

Adjustable Range . . .	J95 — Various ranges between 0 and 500 psi limits. J96 — Various ranges between 0 and 180 psi limits.
Switch Differential . . .	J95 — Factory pre-set for any differential between 2 and 30 psi. J96 — Factory pre-set for any differential between 3" W.C. and 2 psi.
Switch Ratings	Up to 15 amps. at 115 or 230 volts A.C. 20 amp. A.C. or D.C. switches also available.
Switch Types	N.O., N.C., or Double Throw — no neutral position.
Maximum Pressure . .	J95 — Up to 600 psi. J96 — Up to 180 psi.
Electrical Connections .	J95 — Lead wires attached to screw type terminals on switch via ½" NPT opening. J96 — Lead wires attached to terminal block via ¾" NPT opening.
Pressure Connection . .	Via a ¼" female NPT connection.
Enclosure	J95 — Cast iron with a gray, baked-enamel finish. For use in Class I, Groups C and D locations. J96 — Cast iron base and aluminum cover. For use in Class I, Group D; Class II, Groups E, F, and G; or Class III locations.
Mounting	Surface-mounted by four corner holes with clearance for ¼" screws.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. For information on modifying standard units or providing custom-built units, consult a UE application engineer. For additional data on the Types J95 and J96, request new literature available.*

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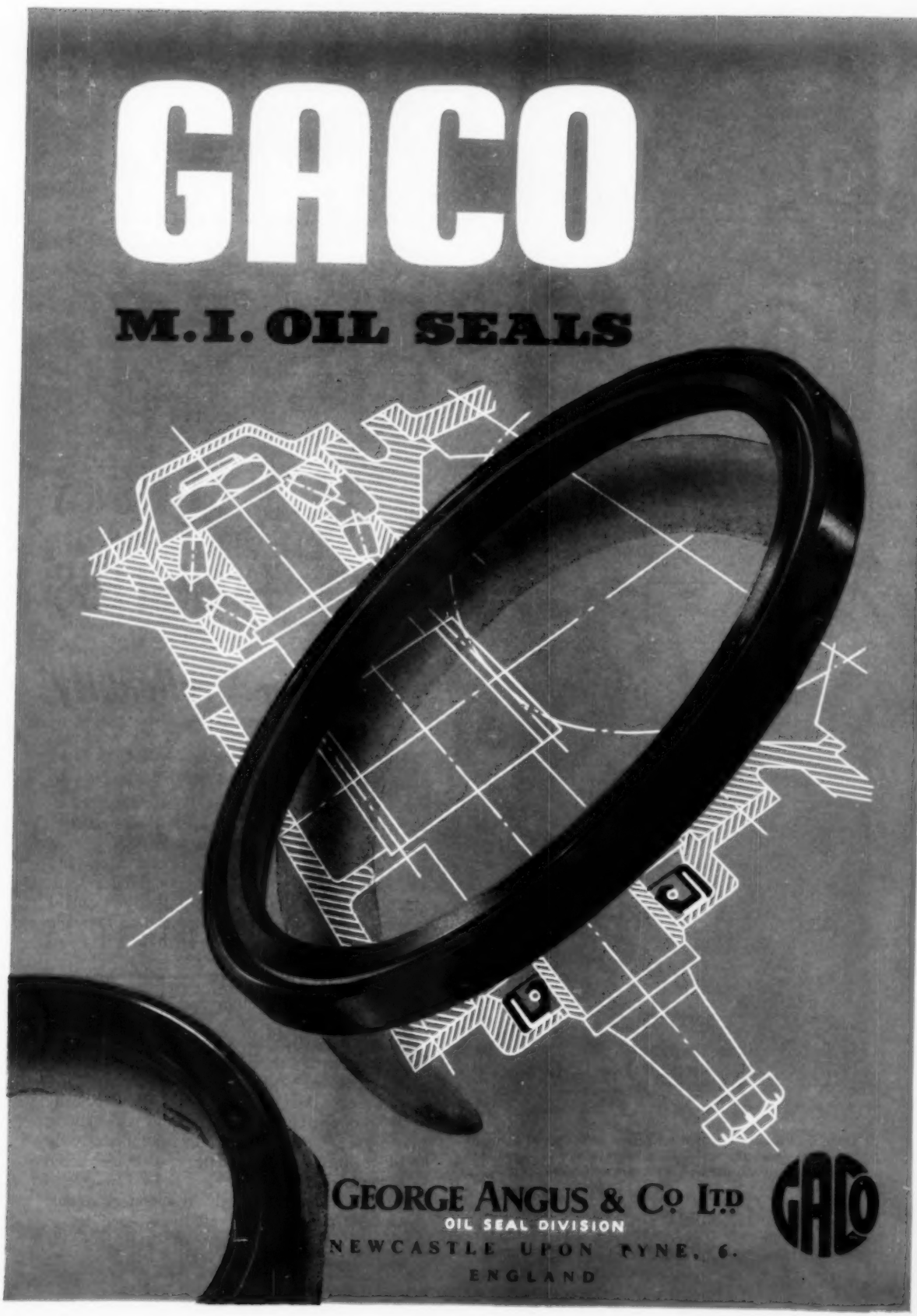

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OIL SEAL DIVISION
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ENGLAND

GACO

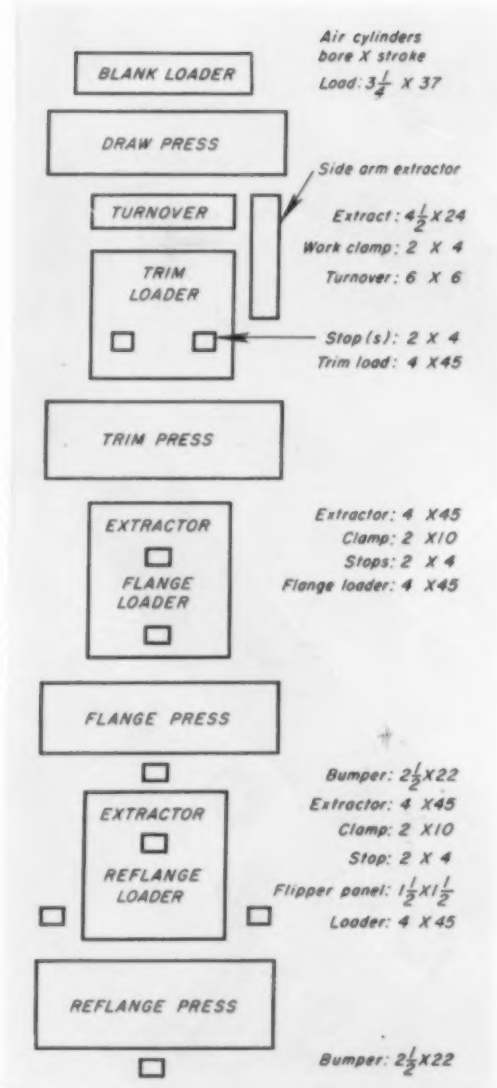
Circle 12 on Reader Service Card

PNEUMATIC APPLICATION ARTICLE

To automate operations at Ford's Cleveland stamping plant, automatic work handling and transfer devices have been developed. Because of speed, simplicity and flexibility, electrically controlled air powered mechanisms were designed. What's the key to minimum downtime on this equipment? Standard components are used wherever possible.

AIR POWERS PRESS TRANSFERS

...for speed, reliability

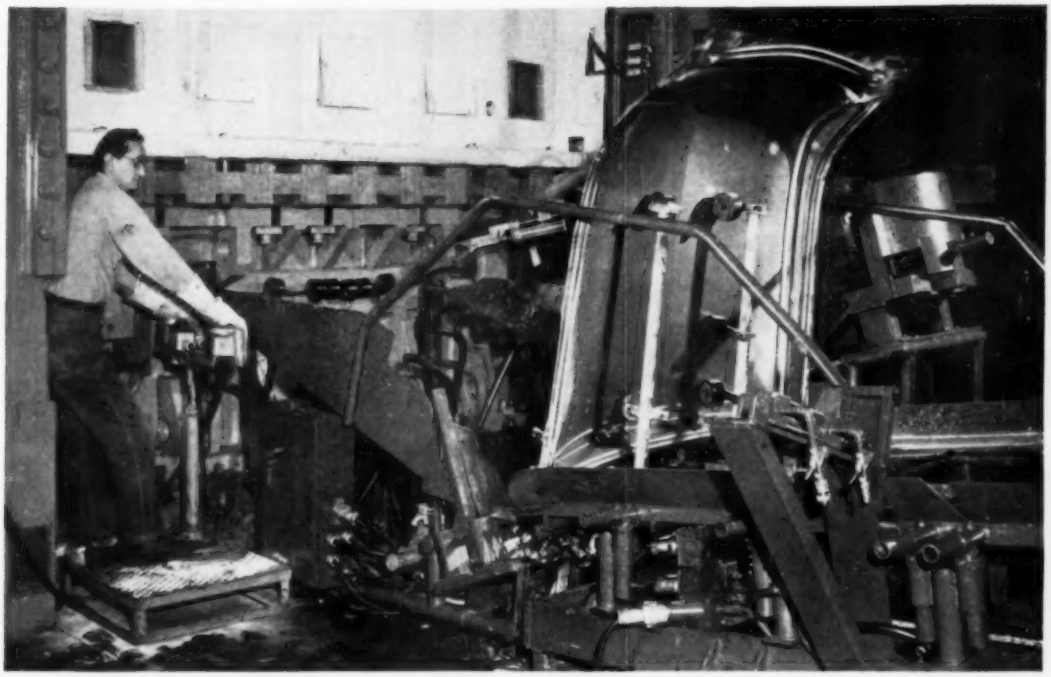


Here's a layout of 4 of the presses in the hood stamping line, loading, unloading, turning, and postitive location is accomplished with air cylinders.

TWENTY-two major press lines in the new Cleveland Stamping Plant of the Ford Motor Company abound in pneumatic handling and transfer devices. Most of the press work is with large area pieces—side panels, instrument panels, doors and hoods. In addition to efficient loading and unloading of the blank or formed parts into and out of the presses, additional provisions had to be made for such operations as clamping, stops, hold-down and turnovers.

Since the presses are mechanical, the choice of a power means for handling and transfer was unprejudiced.

Plant management, working with basic electrical control circuits, with emphasis on limit switches, found it possible to get perfectly satisfactory transfer operations on press line with pneumatically operated mechanisms. The pneumatic systems were simple and easy to maintain. The flexibility of combined manual and automatic operations gained with limit switches and relay control was used to the full advantage. Individual operators at each press had full control at all times, each set of auxiliary operations being controllable manually or automatically.



HOOD TURNOVER mechanism is at midpoint on its way over and into the trim press. One pair of arms carry the hood into the vertical position, where a second pair lowers it to the transfer. Turnover cylinder, horizontally mounted below track level, drives a train of three gears which control the movement of both pairs of arms.

Low pressure air was used in most circuits. Some circuits operated efficiently at pressures of 40 to 50 psi; a relatively few circuits use as high as 80 psi operating pressure. Low pressure operation, in turn, made the maximum use of limit switches. With limit switches mounted so that it was relatively easy to move them, maximum flexibility was obtained.

A good example of the utilization of electrically controlled pneumatic circuits for transfer operations is the setup of the first four presses in the hood line. Air circuits move stock or pieces into and out of presses, turn the hood over, provide stop and bumper functions, and move pieces from press to press. The fundamental pneumatic circuit is a work cylinder, powered by shop air supplied through standard valving controlled by relays which are, in turn, actuated by limit switches or push buttons to give either automatic or manual control.

SIDE ARM EXTRACTOR is moving in to pull the stamping out of the press and onto a transfer conveyor belt.

Four mechanical presses, the first a draw press of 800 tons capacity, and three others, in turn, the trim press, flange press and reflange press, of 300 to 500 tons capacity, perform the basic operations.

A blank loader cylinder (3-¼ x 37 in stroke with pinion gear and double rack assembly giving a 2 to 1 ratio) pushes a sheet into the die cavity of the draw press. The press, manually operated

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If your present or future sealing needs are not covered in the following tabulation, request complete data (Bulletin 7) and recommendations for YOUR particular problem.

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36,000 RPM	¾" Shaft	200° F	Kerosene	300 PSI
3,500 RPM	¾" Shaft	150° F	Aviation Gasoline	60 PSI
"SEALOL" — Sealed Hydraulic Pumps & Motors				
1,800 RPM	1⅛" Shaft	Room Temp.	Ucon Hydraulic Fluid	1500 PSI
11,000 RPM	2¼" Shaft	200° F	Lube Oil	20 PSI
"SEALOL" — Sealed Gear Boxes & Speed Reducers				
6,800 RPM	5" Shaft	125° F	Lube Oil	Atmos. Pressure
18,000 RPM	1¼" Shaft	150° F	SAE 10	20 PSI
"SEALOL" — Sealed Agitators & Mixers				
80 RPM	2¾" Shaft	350° F	Steam and Hot Air	Atmos. Pressure
300 RPM	1" Shaft	450° F	Acetone Vapor	50 PSI
"SEALOL" — Sealed Gas Turbines				
15,000 RPM	1⅝" Shaft	300° F	Alcohol Vapor	65 PSI
7,700 RPM	5¼" Shaft	356° F	Lube Oil	2 PSI
53,000 RPM	1" Shaft	350° F	Oil and Steam	350 PSI
"SEALOL" — Sealed Compressors & Super-Chargers				
3,024 RPM	3½" Shaft	250° F	Oil Mist and Air	7½" Hg. abs.
70,000 RPM	½" Shaft	230° F	Oil Mist and Air	19" Hg. abs.

Also: dynamometers, drill press spindles, steam compressors, oscillating dryers, air chucks, natural gas flow meters, rocket fuel, oxidizer applications, and many others.

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SEALOL

THE BALANCED PRESSURE SEAL

AIR POWERS PRESS TRANSFER

by double pushbuttons, is cycled, drawing the blank in the first hood operation.

As the press opens and the gauge pins drop below the level of the formed hood, a lifter raises the hood out of the die and a side arm extractor unloads it. The swivel mounted extractor carriage has two cylinders. The larger extractor cylinder (4½ x 24 in stroke with 2 to 1 ratio) extends, moving the smaller jaw cylinder (2 x 10 in) in position in front of the hood. The jaw cylinder extends, clamping the jaw on the hood. The extractor cylinder then retracts and near the end of its return stroke, the jaw cylinder retracts opening the jaw and dropping the hood.

The hood moves down a series of free rollers on an incline away from the press and bottoms in a turnover fixture. As the hood bottoms in the fixture, limit switches for the turnover cylinder are actuated. The hood is picked up by a pair of arms, carried to a vertical position, where a second pair of arms lower it to the transfer.

The turnover cylinder horizontally mounted below the track level, drives a train of three gears which control the movement of both pairs of arms.

TURNING PART BETWEEN STATIONS

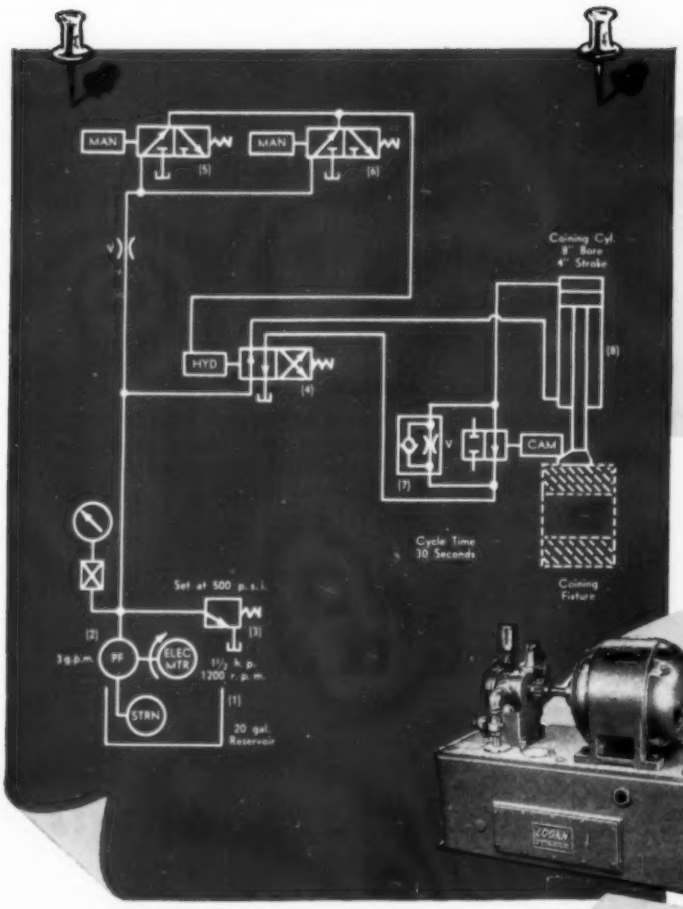
Transfer between the draw and trim presses has two panel positions. The hood is moved from the first or turned over station to the second or load station by dogs on roller chain driven by the loading cylinder. It is necessary for hoods to be in both positions, one in the turnover and one in the loading position, for the automatic operation to take place.

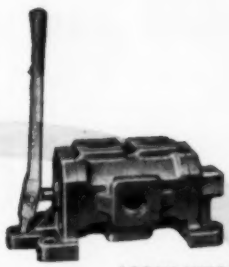
A loader cylinder on the trim press loader drives a series of sprockets through roller chain to push the hood into the die. The press is cycled and the extractor assembly pulls out the trimmed hood and drops it on the next transfer. Panel stops (vertically mounted cylinders 2 x 4 in stroke) hold the hood in position until the flange press is ready for the part.

There are two differences however, between the flange and the reflange loader. The loader to the reflange press is fitted with flipper panel stops operated by small air cylinders. The flipper panels stop the flanged hood panel before the reflange press. A bumper stop positions the hood in the die for both presses.

One of the major advantages of the electro-pneumatic circuits is that practically all items or units are stock items. Design has been adapted in most cases to utilize standard cylinders, valves, limit switches and relays whenever possible. Cylinders are standard, the sroke being practically the only variation from catalog items. Valving, for example, is practically all 4-way, single solenoid, poppet type. Obviously, this planning has resulted in large gains in maintenence, stocking and parts deliveries and in overall costs. ▼▼▼

HYDRAULIC CIRCUITS





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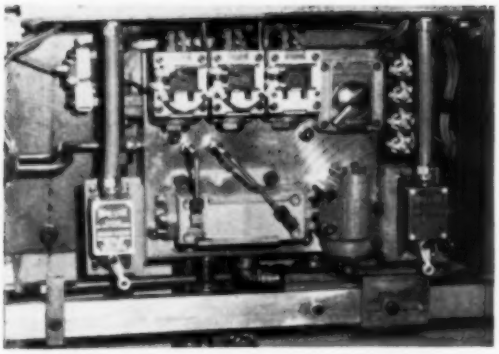

FIG. 1. LIMIT SWITCHES WITH ROLLER ACTUATORS are alternately tripped by reciprocating motion of carriage. Actuating cams are easily adjustable for flexibility of machine operation.

How to select and use

LIMIT SWITCHES

. . . for fluid power circuits

Three general uses of limit switches for control of fluid power equipment are:

(1) to control a machine motion such as stopping or reversing a hydraulic press,

(2) to coordinate the machine motions in an established sequence such as the action in a molding press where the injection ram moves forward when the die ram has closed and

(3) for signaling in instrumentation, counting, or timing.

● By Allan E. Morris
Associate Editor APPLIED HYDRAULICS

LIMIT switches are available in a great variety of design and construction. The features which should be considered in selecting a limit switch for a particular application are:

a. Type of actuation—roller arm, push rod, and variations of these.
b. Type of operation—spring return, non-spring return, amount of pretravel, overtravel, and differential movement.
c. Physical size.
d. Enclosure and environmental conditions.
e. Electrical connections—screw terminals, solder terminals, open or closed.
f. Contacts—single or double break, overlapping or non-overlapping.
g. Electrical operation—single or double pole, single or double throw.
h. Electrical rating—continuous, inrush, and interrupting capacity, maximum voltage.

Little standardization has been applied to limit switches as with other control components such as pushbutton switches and motor starters. However the electrical differences between limit switches of the same general type are small between various manufacturers. Current ratings and number of contacts are much the same. The main differences are in the

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Special female grease tap.

Rigid male pipe

Rigid 37° SAE (JIC) male

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90° angle

Male to Female—

Straight

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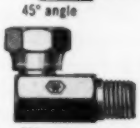

90° angle

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mechanical features such as location of mounting holes, amount of pretravel, operating force, means of adjusting the actuating arm, etc.

ACTUATION

Many different styles of actuation are available for limit switches, and these permit use in a great variety of applications depending upon the machine motion which actuates the switch. Frequently a basic switch can be fitted with different actuators to suit the installation. While several designs of actuator may satisfy an application, the accuracy and consistency of the switch operation depends upon the selection of the most suitable one. The two basic types of actuators are the push type and the roller arm type. In the roller arm type, the rotating arm can be adjusted at different angles to suit the machine application. Some limit switches can be made spring return in either direction or can be converted to a non-spring return in either direction. Fork type limit switches have a form of roller arm actuation, and they maintain contact in either of two positions.

OPERATION

When the machine actuating member contacts the limit switch, the switch actuator moves for a certain distance before operating. This distance is called pre-travel. After the switch trips, the force may remain to move the actuator for a short distance called overtravel. In a spring-return model, after the force is removed, the actuator moves back past the tripping point to the reset point. The distance between the forward trip point and the return reset point is called the differential. This differential is a function of the contact air gap which in turn is dependent upon the interrupting capacity of the switch. J.I.C. standards state that limit switches shall be installed so that accidental overtravel will not damage them.

ENCLOSURES

Limit switches for machine tool applications are oil-tight. Oil-proof limit switches are recommended for industrial control applications, because almost every machine is subject to oil, or other foreign liquids, Care must be taken in designing the installation of the switch to minimize the entrance of foreign material into the limit switch. The conduit opening should be located to prevent leaks into the unit and the conduit should be threaded and sealed. In some models a transparent window is put into the case so that the switch can be inspected without removal or disassembly. This feature is especially useful on large automatic machines where down time must be held to a minimum. Explosion-proof enclosures are available for hazardous atmospheres.

CONTACTS

Most limit switches for machine control are double-pole, double-break, double-throw. On actuation, usual-

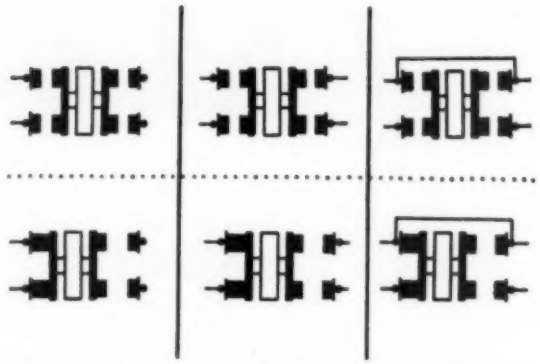

FIG. 2 CONTACT ARRANGEMENTS showing spring-centered and spring-return contacts.

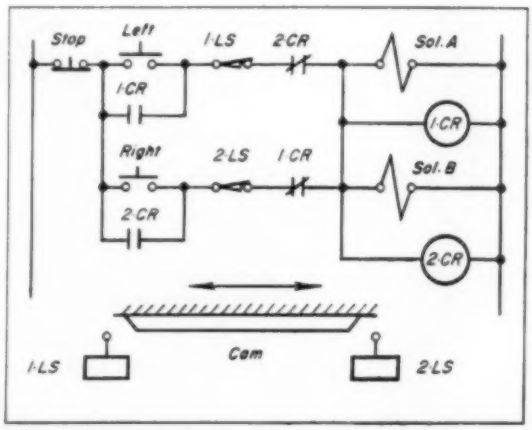

FIG. 3. RECIPROCATING MOTION with one cam and two limit switches.

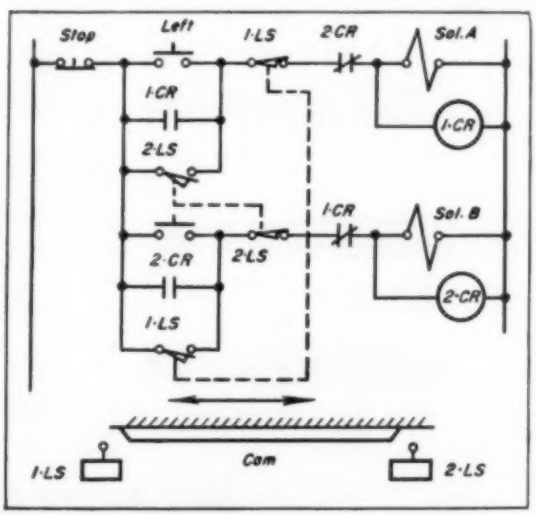

FIG. 4. LIMIT SWITCH contacts in parallel with the push-button switches produce automatic reciprocation.

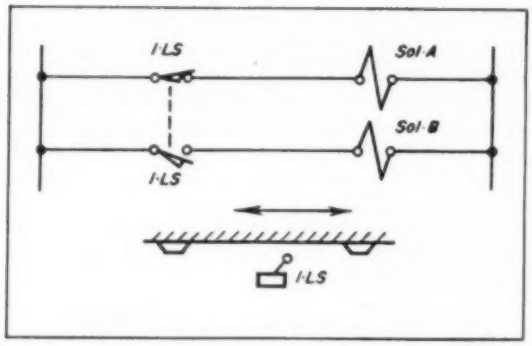

FIG. 5. ONE LIMIT SWITCH AND TWO CAMS control reciprocating motion.

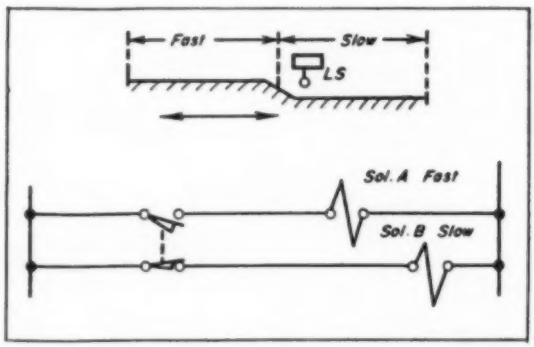

FIG. 6. TWO SOLENOID VALVES are controlled to produce fast and slow motion.

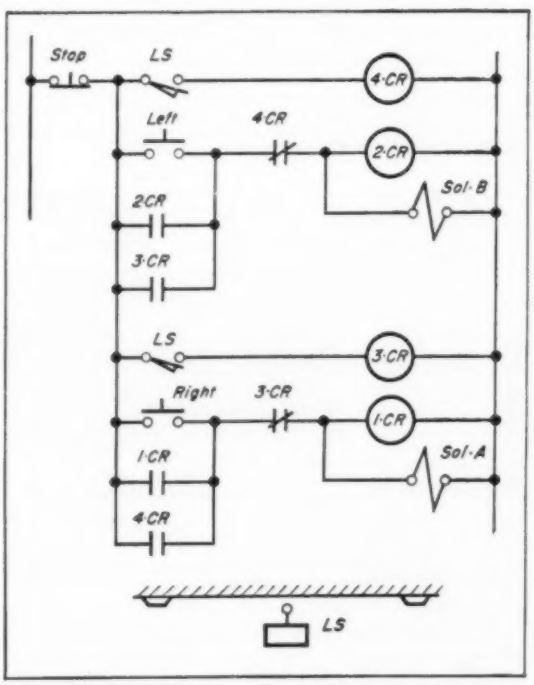

FIG. 7. AUTOMATIC RECIPROCATION with stopping or reversing at any point.

ly the normally-closed contacts open before the normally-open contacts close. However limit switches may be obtained in which the normally-open contacts close before the normally-closed contacts open. This is called overlapping contacts and the opposite action occurs when the switch resets. This feature is used on circuits where a transfer from one circuit to another is required.

In a typical limit switch for machine applications, the contacts are rated for 10 amperes continuous current, and for 30 amperes interrupting and inrush current.

OPERATION AT END OF TRAVEL

Limit switches are often used for limiting travel or for reversing reciprocating motion. This can be done with two limit switches and one cam, or one limit switch and two cams. Figure 3 illustrates the former method applied to a hydraulic cylinder controlled by a solenoid-operated, 4-way valve. Pressing either the Left or Right switch energizes either solenoid A or B and either relay 1-CR or 2-CR. The relays lock in through contacts in parallel with the pushbutton switches. When the piston reaches either the left or right extreme position, the corresponding limit switch is actuated to de-energize the solenoid valve. Contacts of each relay in the alternate circuit form a protective means to prevent both solenoids from being energized at the same time, should the pushbutton switch be accidentally pressed. Pressing the Stop switch de-energizes the system at any point.

In order to make the circuit of Figure 3 automatically reciprocating, contacts of the limit switches are added in parallel with the Left and Right switch as shown in Figure 4. These contacts act in the same way as the pushbutton switches to automatically reverse the motion.

Figure 5 shows the use of one limit switch with two cams to control reciprocating motion. In the design shown, the limit switch is one which maintains contact in either position such as the fork-type switch. The solenoids are energized alternately at the end of each stroke providing automatic reciprocation. A disadvantage of this circuit is that the feed must travel to either extreme before reversing, unless some means is incorporated to bypass the limit switches. This can be a two-pole momentary switch which closes the in-active circuit and opens the active circuit. Since the switch removes the overtravel protection of the limit switches, a momentary switch is used.

The circuit of Figure 7 provides automatic reciprocation and permits stopping or reversing the motion at any point. The limit switch closes a separate pair of contacts in either extreme position and has a spring return to center position in which both sets of contacts are open. Closing the Right switch energizes solenoid A of a 4-way solenoid valve and relay 1-CR which locks in. When the piston reaches the end of its travel right, the limit switch is actuated to close contacts LS in series with relay 3-CR. Relay 3-CR de-energizes relay 1-CR and solenoid A, and energizes solenoid B and relay 2-CR which locks in.

When the carriage reaches the extreme left travel, the contacts LS in series with relay 4-CR are closed to actuate relay 4-CR and reverse the motion.

OPERATION DURING TRAVEL

Limit switches which initiate an independent action at some point in the machine operation are actuated while the machine member is in motion. A circuit for controlling two solenoid valves to give fast and slow operation is shown in Figure 6. When solenoid A is energized, the motion is fast; when solenoid B is energized, the motion is slow. The double-throw limit switch is actuated by the reciprocating cam in the "Fast" region and deactuated in the "Slow" region.

LIMIT SWITCH DEFINITIONS

Operating force—Amount of force required to actuate the limit switch.

Release force—Maximum force at which the limit switch will reset.

Pretravel—Distance actuators moves from free position to trip position.

Overtravel—Distance actuator moves beyond trip position.

Total travel—Distance actuator moves from free position. Total travel is the sum of pretravel and overtravel.

Differential travel—Distance spring-return actuator moves in returning from extreme position to reset point.

Overlapping contacts—When a limit switch with overlapping contacts is actuated, the normally-open contacts close before the normally-closed contacts open. On resetting the normally-closed contacts close before the normally-open contacts open.

DESIGNING FOR SAFETY

Control circuits should be designed so that no part of the machine cycle can be initiated by manually actuating a limit switch. Sometimes operators attempt to use machines while interlocked covers or guards are off, and they will manually actuate a limit switch. Not only can this result in improper sequence and danger to the machine, but operating the machine under unsafe conditions is a personnel hazard. The improperly designed circuit in Figure 9 illustrates how relay 2-CR can be actuated by pressing limit switch LS. In the circuit of Figure 10 this has been corrected by the proper use of relays. Closing the start switch actuates relays 2-CR and 1-CR which locks in. This energizes solenoid A of a 2-position valve. When the limit switch is actuated, relay 2-CR is deactuated and relay 3-CR is actuated. Contacts of relay 3-CR in parallel with the coil of relay 1-CR short out relay 1-CR. When the limit switch is deactuated, relay 3-CR is deactuated and the cycle must be initiated again. The cycle cannot be initiated by actuating the limit switch.

Another means to prevent manual operation of limit switches is by the proper design for their installation and actuation. In Figure 8A an unsafe condition exists because the limit switch can be manually actuated to start the action regardless of the position of the cam. In Figure 8B the limit switch starts the action in the deactuated position and it cannot be deactuated manually to start the action. ▼▼▼

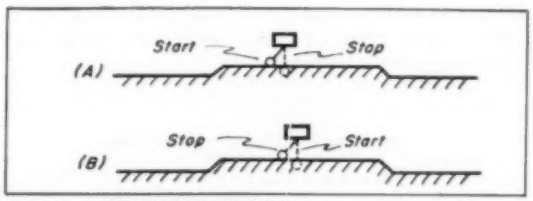

FIG. 8. CAM ARRANGEMENT can prevent unsafe actuation of limit switches.

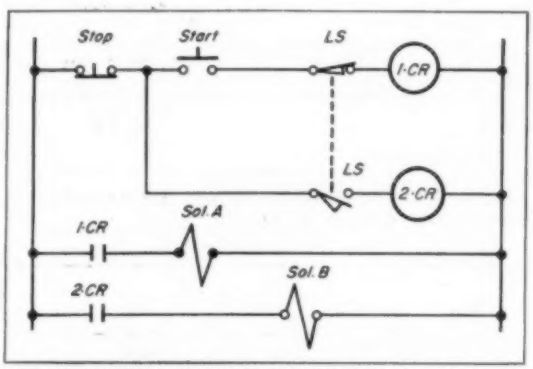

FIG. 9. IN THIS UNSAFE CIRCUIT, limit switch can be actuated manually to energize relay 2-CR.

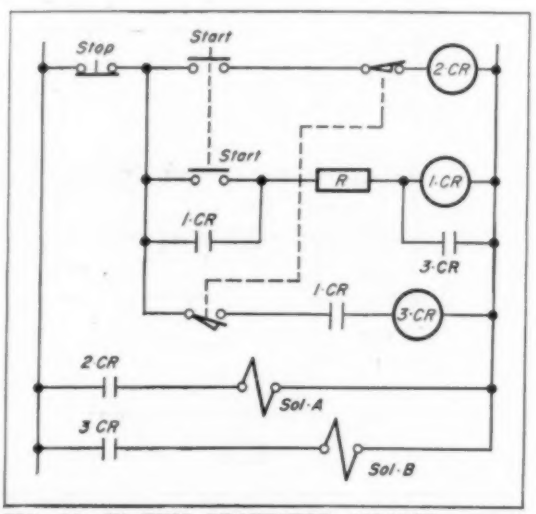

FIG. 10. IN THIS PROTECTED CIRCUIT, manual actuation of the limit switch cannot initiate the cycle.

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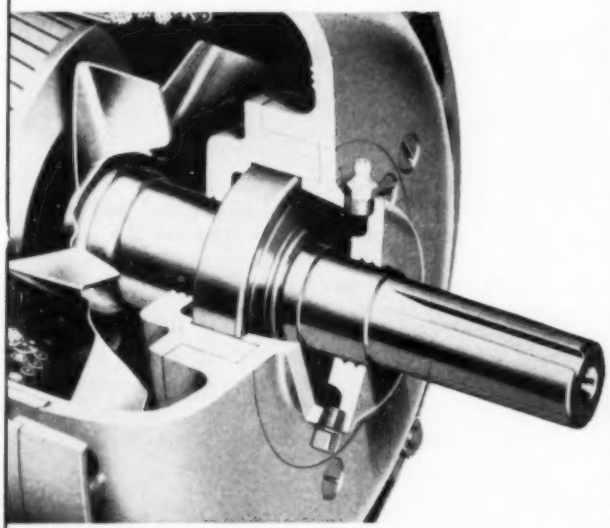

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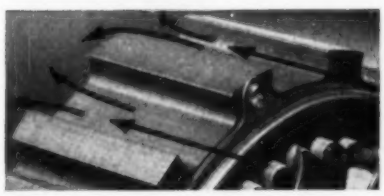

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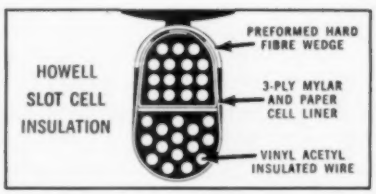

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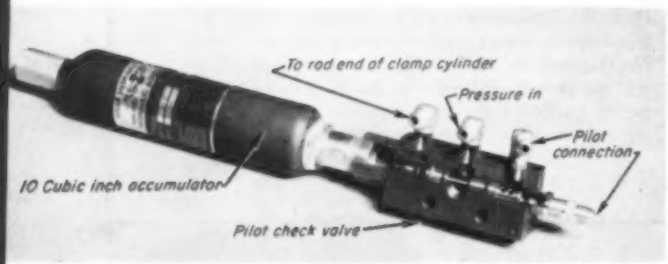

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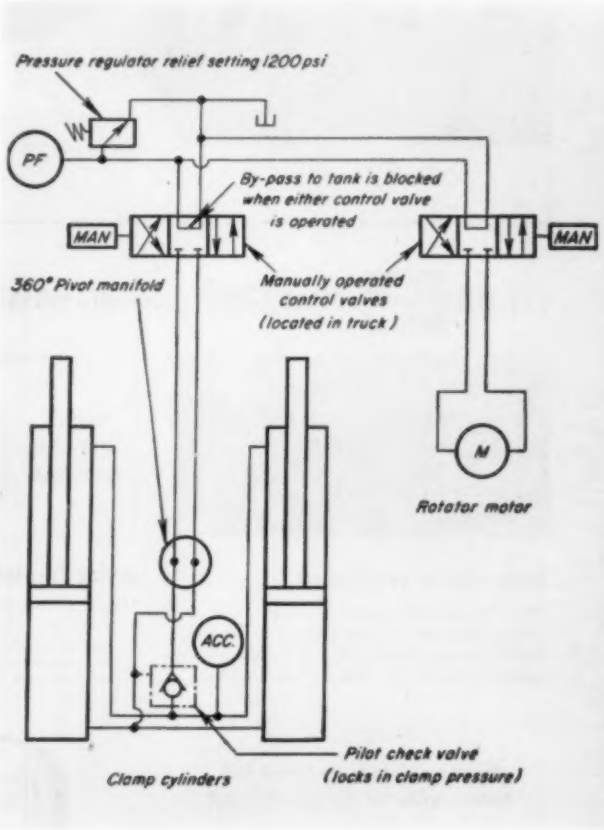
A four plunger control valve is used instead of the standard two plunger valve that normally operates only the hoist and tilt cylinders. This simplifies the entire hydraulic system as all the components can be controlled from a central location rather than maintaining separate controls for the attachment. The system relief is an integral part of the control valve.

In instances, where clamp pressure must be lower than normal system pressures, a secondary relief valve is incorporated into the clamp hydraulic lines.



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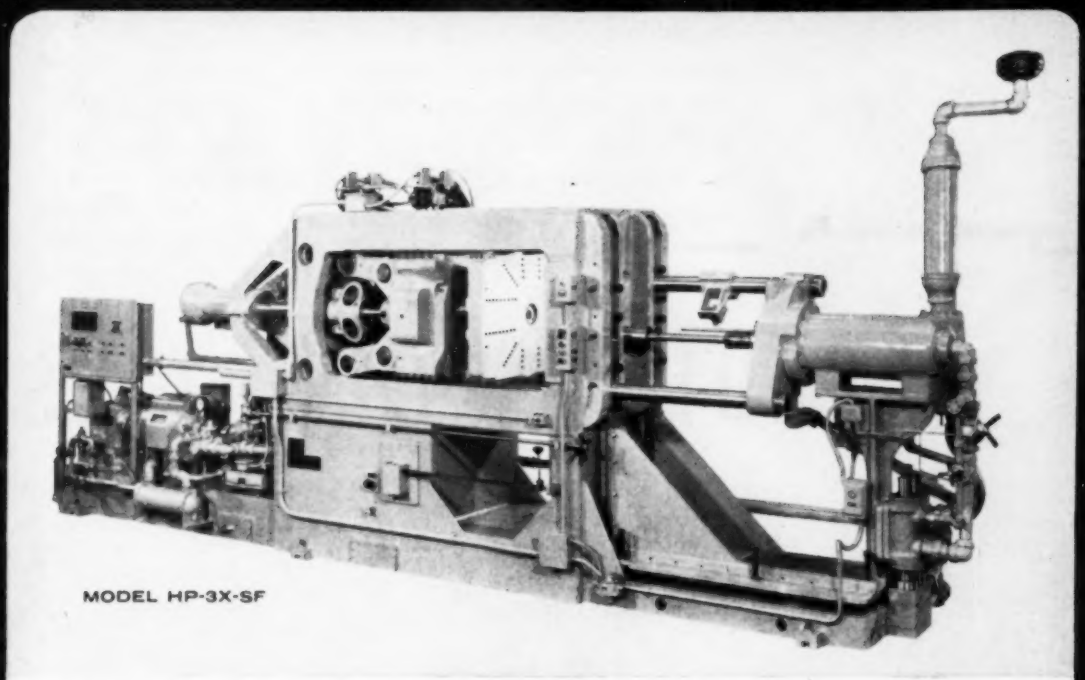

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• By L. B. Taplin

• ***BULK MODULUS*** . . . or compressibility is probably the most important fluid characteristic to be considered in a servo application. This not only determines the static rigidity of the system but influences the amount of gain or amplification which a servo can have. Since the servo operates on an error signal, the higher the gain, the smaller the error signal required for operation. Servomechanisms are characterized by their degree of stability with increased gain. In many cases as the gain is increased, the system will eventually break into oscillation. The natural frequency of oscillation is related directly to the square root of the bulk modulus of the oil. Thus a high bulk modulus results in a high natural frequency which, in turn allows a larger gain to be used. The higher the bulk modulus, the lower the error in the servomechanism. Entrained air in the fluid results in a low modulus, especially at low fluid pressure. It is very desirable that the fluid possess low foaming properties, and a means of absorbing air without changing bulk modulus.

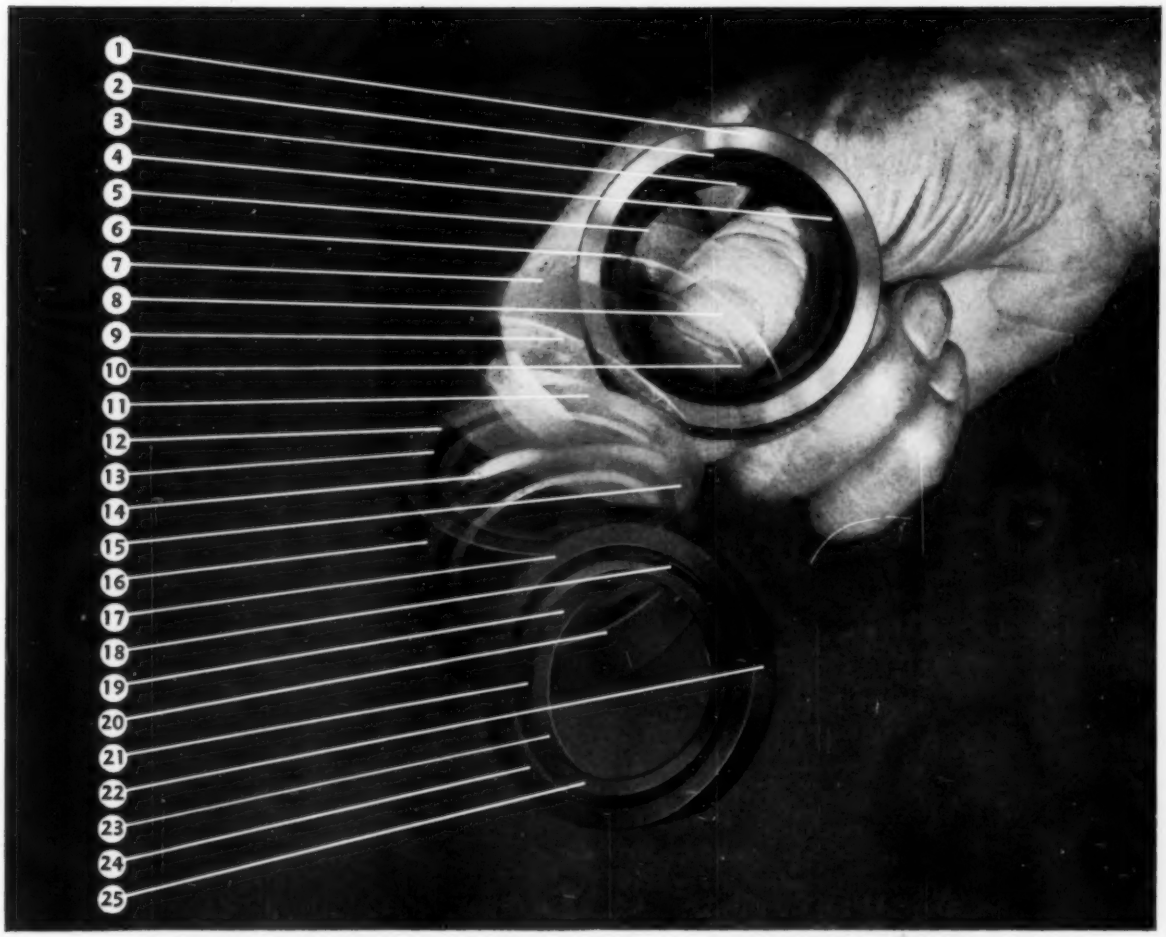
• ***HIGH VISCOSITY INDEX*** . . . is especially important in systems having fluid metering devices because the only damping available may that due to leakage. Any appreciable change in viscosity can change the damping characteristics of the system and make it unstable. For example, a poppet which relies on a dashpot action for stability may lack sufficient damping at the dashpot if viscosity drops too much. In many applications, particularly missile systems, the leakage specifications are severe and temperature variations are large. The result is that extremely small clearances must be used to limit the leakage at high temperature. At low temperature these clearances are often so small that they cause poor efficiency and even malfunctioning in some components such as valves. The actual viscosity of the fluid should be no lower than the present MIL-0-5606 specification because clearances on present components are small and rather difficult to maintain.

• ***SPECIFIC GRAVITY*** . . . of the fluid can contribute to the natural frequency of the servo because in some installations the fluid mass may be an appreciable part of the total load. Since the natural frequency is inversely proportional to the square root of the total moving mass, a fluid of low specific gravity permits a higher gain in the servomechanism.

• ***HIGH SPECIFIC HEAT*** . . . and a high heat transfer coefficient are important because servo circuits are usually closed loops, and in aircraft installations components are of the minimum size and weight. For a certain energy loss in the system temperature rise must be as low as possible, and a maximum amount of heat must be rejected from the fluid.

• ***LUBRICITY*** . . . of the fluid is of paramount importance because low friction is necessary for system accuracy. Dry friction produces dead zones and hysteresis in the system. In some cases dry friction can cause instability, because in the friction region the system will lose its feedback signal and hunt. Lubricity is, of course, important for bearing and sealing surface life. ▼▼▼

L. B. TAPLIN, *Project Engineer, Vickers, Inc., Detroit, Mich.*



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11. Bonded Case Seal Straight Lip Thin Rind Type
12. Bonded Case Seal Limited Contact Lip Thin Rind Type
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JET ENGINE CONTROL...

SERVO PUMP or SERVO VALVE

Turbojet engine control systems using oil hydraulic power are practical, effective and efficient. They can be designed around either a servo pump or a servo valve. Each has its advantages and limitations, and there is no rule of thumb or simple nomograph which can be used to give a quick answer to the question of which is best for an application.

• By L. D. Taylor

IN DESIGNING the fluid power control circuit for a turbojet engine, the obvious question is, "How can we determine what circuit is the most advantageous?" Such a decision can be made only after first gaining an understanding of the operation of various basic circuits together with their advantages and shortcomings. Two basic controls for use with turbojet engines are the servo pump and the servo valve. In deciding which type of system to use, the most important factors to consider are rate of response, gain characteristics, power loss, and weight.

SERVO PUMP SYSTEM

The title "Servo Pump" is commonly applied to a particular design that is readily adaptable to servo or feedback control circuits. First, it is a variable displacement pump; the rate and direction of fluid delivery can be varied and controlled. Second, the amount of power required to control rate and direction of flow is relatively

L. D. TAYLOR, *Staff Engineer, Vickers, Inc., Detroit, Mich.*

small compared to the power capabilities of the pump. This displacement control is contained within the pump itself. Third, the servo pump is as self-sufficient a unit as possible. Although this is not a necessity, it is a desirable requirement.

Figure 1 is a typical servo pump schematic. Displacement of this pump can be varied from full flow in one direction to full flow in the other by rotating or stroking the yoke about its pintles. The force to move the yoke is provided by the stroking piston. Generally this piston is a 2:1 area type with constant pressure applied to the small or rod end area.

The movement of the stroking piston is controlled by regulating the flow of oil to the head end of the piston. Regulation is obtained by the use of a metering valve. When the metering valve is moved in one direction, it admits oil under pressure to the head end of the piston. When moved in the other direction, it allows oil from the head end to drain to tank. This moves the stroking piston according to the position of the metering valve.

The metering valve is controlled by a mechanical linkage to some external signal mechanism or by an electro-mechanical transducer such as a torque motor. In the circuit shown in Fig. 2 the external signal mechanism is either an electronic or a magnetic amplifier. In general only a small amount of power, either electrical or mechanical, is required to move the valve. Thus, the high power output of the pump can be controlled by the application of small input or control power.

The metering valve controls direction and rate of change of pump output. It does not control the final amount of pump output. For this control some means must be provided to close the valve when the desired pump displacement has been reached. This is easily achieved by either a mechanical linkage or an electronic feed-back arrangement.

With a mechanical linkage arrangement, an input displacement is put into the valve by moving a lever. This causes the valve to be displaced, and oil is admitted to the piston. A linkage from the piston then moves the valve back towards its center neutral position to stop the piston. This mechanism is often called a hydraulic amplifier.

. . . servo control of pump displacement requires little power . . . metering valve controls direction and rate of change of pump output . . .

Similar valve control can be achieved by feeding back electronically instead of mechanically. In this case, the initiating signal is an input voltage to an amplifier and results in an electrical current signal to a torque motor. The feedback signal comes from an electro-mechanical transducer such as a synchro attached to the stroking piston. The electrical signal, from the synchro is fed back into the amplifier and is of opposite polarity to the initiating signal so that it causes the ampliifer to send a counteracting signal to the torque motor-valve reducing the valve displacement to zero.

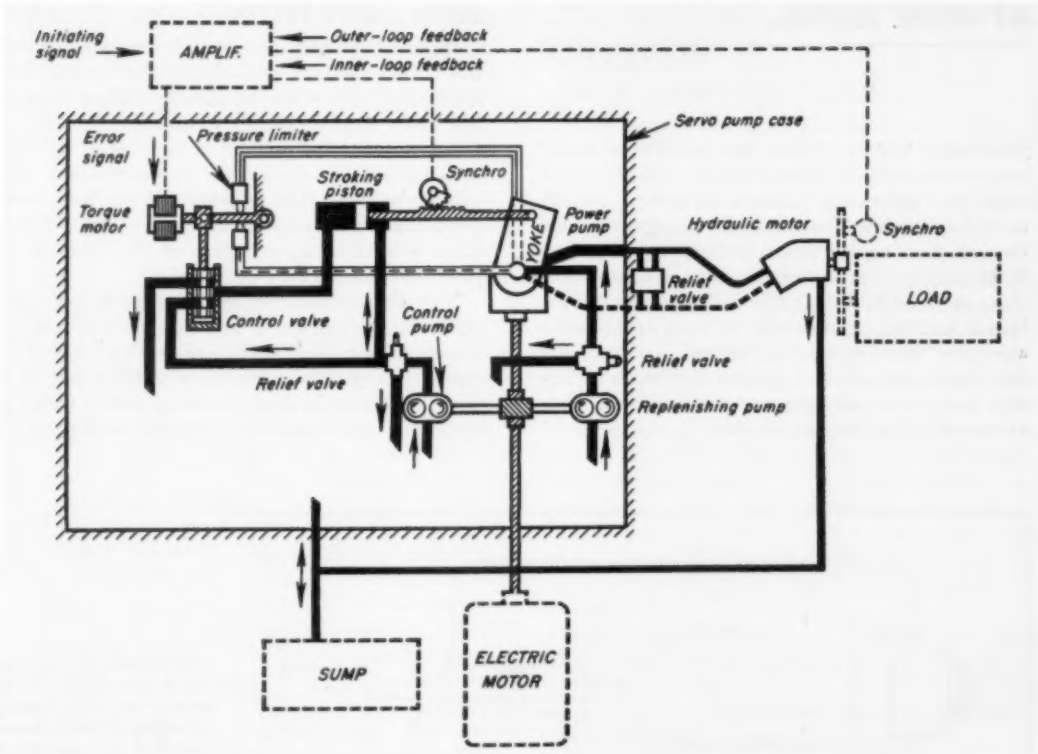
In addition to the mechanism described, the servo pump may also contain two auxiliary pumps and their pressure regulating systems. One auxiliary pump supplies control pressure to the stroking system; the other supplies replenishing and supercharge oil. Pressure regulating valves and filters for both auxiliary circuits are also incorporated. Thus a servo pump is a complete hydraulic power system, except for a reservoir and oil cooler.

A typical control circuit using a servo pump is shown in Figure 2. Here the control mechanism is a mechanical linkage. Motion of the lever in one direction will cause oil to flow out of the top line and in through the bottom line moving the load actuator to the right. Motion of the input lever in the opposite direction will reverse the flow of oil causing the load actuators to move to the left. Position control of the load is obtained by a feedback from the load that returns the pump to zero displacement when the desired load position is reached. The feedback can be electrical from a synchro or potentiometer, or it can be mechanical. The specification of the type of feedback is a function of the application and not a limitation imposed by the servo pump.

In outlining the basic characteristics of a servo

7 STEPS IN DESIGNING A SERVOMECHANISM

1. Prepare schematic diagrams of possible designs.
2. Determine component sizes from required output power and available input speed, taking into account the maximum pressure.
3. Compute fluid line sizes from fluid velocity and allowable pressure drop through the line. Higher fluid velocities than normally recommended can be used because maximum flow occurs infrequently.
4. Calculate the weight of each proposed system including fluid lines.
5. Develop mathematical transfer functions for each system to determine the potential performance of each. These equations indicate total gain for the actuator area, leakage coefficient and other factors.
6. Calculate heat rejection or losses depending on duty cycle to determine heat exchangers required and temperature of the components.
7. Consider problems of mounting components, accessibility, ease of maintenance and other factors before finalizing design.



IN SERVO PUMP CIRCUIT pump displacement is controlled by piston which actuates yoke. Piston is controlled by metering valve which regulates flow to head end of piston. Constant pressure is applied to rod end of piston.

pump circuit, a primary consideration is that the servo pump, like all hydraulic pumps, is a flow generator. That is, a displacement of the pump yoke results in a flow and not a pressure. Pressure in a servo pump circuit is the result of application of load to the load actuators. This means that the rate of movement achieved at the cylinders is independent of the pressure in the system. Controlwise this results in constant gain. This means that response is dependent on the input signal only and not on load reactions or other disturbances.

The second characteristic which should be noted is also related to the fact that a servo pump is a flow generator. It is characteristic of this oil hydraulic system that the pressure level in the system is only that required to overcome or hold the load. Therefore the lowest possible average pressure in the system is obtained, and losses in the main system because of leakage will be a minimum. In addition, the system can utilize higher instantaneous pressures than can be tolerated in other systems because the only pressure limitation, besides the mechanical factors of the components is the setting of the relief valve. As previously stated the pressure is a function of the load reaction only. It is not limited by such things as the setting of a pressure compensated pump or the demands of parallel systems working from the same hydraulic pressure source.

Losses in the system result from main system leakage and constant control flow losses. In some cases the replenishing pump losses must also be added. The main system leakage, as previously discussed, will be a minimum. The magnitude of the other losses is only a function of the maximum acceleration desired (control valve flow represents acceleration) and the amount of replenishing flow required.

The servo pump control system can be designed to deliver maximum force at any load velocity, including maximum. This is possible because there are

. . . . type of feedback to the pump control depends on application . . . it is not limited by the pump

no main line restrictions, other than the lines themselves. The significance of this will become apparent when the servo valve control system is discussed.

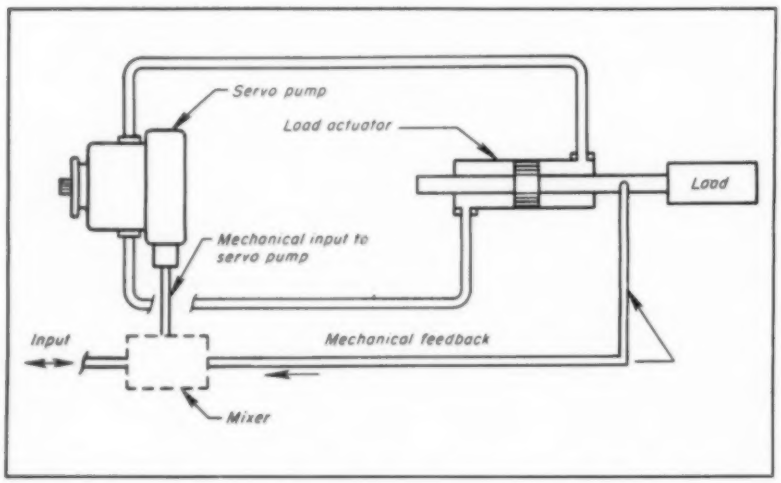
The servo pump must be mounted on a gear box, and this gear box is usually located a relatively long distance from the actuators in engine application.

This means that the volume of controlled oil under compression will be relatively large. Oil acts like a relatively tight spring. In order to achieve as high an "oil spring rate" as possible, it is important that the volume of controlled oil be held to a minimum by keeping the lines between pump and actuators as short as possible. This is especially important if the load is primarily a mass type or has a considerable amount of static or starting friction. A system that has a constant load, or a viscous friction or spring-type load is not as adversely affected by a large volume of oil under compression.

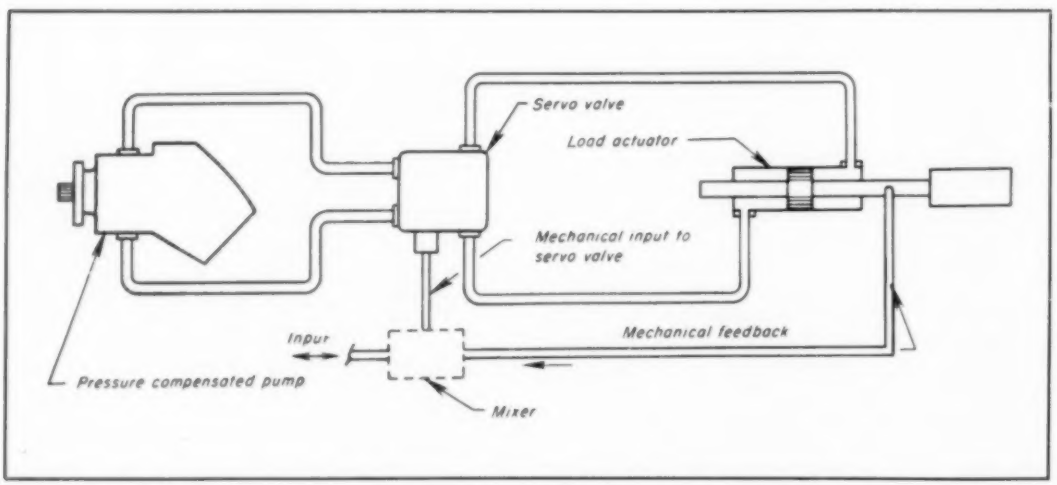
SERVO VALVE SYSTEM

One of the basic characteristics of a servo control is that the valve controls the flow to and from the load by restricting the passage leading from the hydraulic supply. The flow through the valve is proportional to the product of the area of the valve opening and the square root of the pressure drop across the valve. The pressure drop in turn is dependent upon the pressure required to hold or overcome a load. Thus, the gain of the servo is dependent upon the load reaction.

This characteristic of servo valves is not necessarily detrimental but is one that must be well understood. Increasing load decreases the gain of the valve. This generally increases stability but slows down response. To insure a stable system under all operating conditions, the designer must build his



MECHANICAL LINKAGE controls servo pump in this circuit. Position of load is controlled by feedback which puts pump in zero displacement when load is in required position.



SERVO VALVE CIRCUIT uses a pressure compensated pump. Mechanical linkage provides feedback. High response is an advantage of this system because of small amount of oil under compression.

system to be satisfactorily stable at a time when the gain of the servo valve is the maximum possible.

The pressure level in a valve control system is dependent upon supply pressure and load. Supply pressure determines the sum, and load determines the difference in pressure across the load actuators. The maximum force that can be achieved is the supply pressure times the area of the actuating pistons.

The available force at the load piston is not only a function of supply pressure but of load velocity as well. This results from the very nature of servo valves. In order to control flow, a flow valve must have a pressure drop across it. This means that the available pressure at the load is equal to the supply pressure less the pressure drop across the valve. The amount of pressure drop is dependent upon the opening of the valve and the velocity of the oil passing through it. If we consider maximum opening only, it can be shown that maximum horsepower is delivered to the load when two-thirds of the available pressure is across the load and one-third is across the servo valve.

The losses in a servo valve system are similar to those in a servo pump system with the added power loss across the valve. Because mean pressure in the main sytem is higher than in a servo pump system, the leakage loss will be somewhat greater.

At first observation it would appear that the losses across the servo valve would be excessive. Actually, this is not the case. To evaluate this properly, one must consider average loss rather than peak loss. Since these valves are normally used in position type systems, normal position is closed rather than open, and maximum velocity is required only at infrequent intervals. Under most duty cycles losses due to pressure drop across the valve have been small.

SERVO VALVE ADVANTAGES

One major advantage of a servo valve system is a high response which results from two factors. First, it is usually possible to mount the valve close to the load. This results in a small volume of oil under compression subjected to changing pressures. All oil between the supply pump and the valve is at a constant pressure level, and only the oil between the valve and the load changes in pressure. This means that the "hydraulic spring" can be very stiff, giving high control response.

The second characteristic of the servo valve which results in high response is that the valve itself is normally a fairly simple device having low masses. Thus it can be made to move quickly with relatively small applied control power. In most applications, a servo valve system can be made to respond many times faster than a comparable servo pump system. If response is the major design objective, the servo valve system should usually be selected.

Figure 3 is a schematic of a typical servo valve control circuit using a pressure compensated pump. The control is a mechanically operated servo valve. In operation, it is exactly the same as the previously described servo pump control circuit.

In some applications a servo valve system can be made lighter than a comparable servo pump system. This is always the case when two or more independent control systems are supplied from a common hydraulic supply source. However it is generally not true when only one control system is used. ▼▼▼

Characteristics of Jet Engine Control Systems

	SERVO PUMP SYSTEM	SERVO VALVE SYSTEM
RESPONSE	Response is generally higher than non-hydraulic systems but lower than servo valve, oil hydraulic system. Limitations are imposed by oil under compression, the load, and the response of the servo pump stroke control.	High response is possible because of small amount of oil under compression and fast response of the valve itself. Response can be several times higher than the servo pump system.
GAIN	Constant gain; response is dependent on component gain characteristics only and not on load reactions or other disturbances.	Gain of the valve is a function of the load reaction. System must be designed to be stable when gain of the servo valve is maximum.
POWER LOSS	Steady state losses are generally smaller than other types of systems because the average main system pressure is lower. Control losses are small.	Steady state losses may be higher than in servo pump because of leakage and higher main system pressure. Power losses across the valve must be considered.
WEIGHT	Comparatively light for applications with only one control system.	Frequently lighter than servo pump system particularly when two or more systems are to be supplied from a common hydraulic source.

System designs using titanium fittings or tubing should employ the MS flareless type connections for ease of fabrication and to maintain the highest margin of safety from a structural standpoint.

WHAT'S TITANIUM'S FUTURE ... in aircraft hydraulic circuits?

Cost per pound of weight saved with titanium fittings and tubing warrants consideration for their use in aircraft hydraulic and other systems.

Titanium fittings and tubing should be incorporated into future designs on the basis of savings realized in cost and weight and equality or superiority in performance and service life.

• By Don F. Collins

AS SPEEDS of contemporary aircraft reach the Mach 1 and 2 ranges temperature rises are sufficient to weaken present high strength aluminum components. Recognizing this problem, an exhaustive investigation was made to determine whether titanium would provide a satisfactory solution.

It is known that a high strength aluminum alloy fitting decreases in tensile strength when the temperature exceeds 300-325 F. Stainless steel fittings offset the high temperature but increases the gross weight of the airplane. At higher speeds and higher pressures for the operation of hydraulic aircraft systems, aluminum fittings would be completely out of the picture.

Obviously, a material must be found of low weight, reasonable strength/weight ratio, resistance to most temperatures and increased system pressures. Such a material, when machined, must be capable of being assembled interchangeably in our present aircraft hydraulic systems and powerplants. Industrial experience indicates that titanium, commercially pure or alloyed, might meet the necessary aircraft requirements and military specifications. This material has proved itself when used as sheets, strips, bolts and in plates where high temperatures are reached.

The study included titanium AN and MS fittings in sizes -6 and -10. Fatigue tests were made at room temperature and at 400 F on aluminum, stainless steel and titanium tubing. Mallory-Sharon MST Grade III titanium and MST 6AL-4V titanium were used for the fittings. Grade III, a commercially pure product, did not have the physical properties for high temperature evaluation and application. The alloy, 6AL-4V, was used in the high temperature tests because of its high tensile and yield at these temperatures. The titanium tubing, was specified as Titanium seamless tubing, Temper II, Half Hard, an alloy similar to the 6AL-4V titanium.

All slugs for the forged parts were slowly heated to 1650 F, descaled at 1650 F, forged at 1550 F

DON F. COLLINS, *Development Engineer, Aviation Division, The Weatherhead Co. Antwerp, Ohio.*

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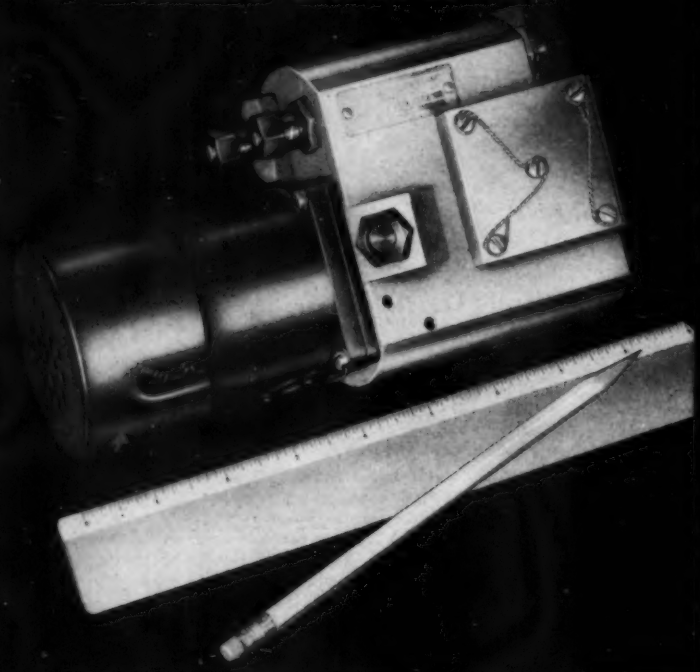

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Unit consists of: positive-displacement pump, electric motor drive, oil reservoir, expansion chamber, porous bronze ten-micron filter, pressure regulating valve, filter relief valve, and expansion relief valve.

SPECIAL UNITS to be built into Servo Systems and specialized projects are available. As illustrated below, Actuators combined Servo-valve and Actuator, and Servo-valve Hydraulic System combinations are being produced by Eastern for custom-specified jobs. If your project involves equipment of this type, write to us for further information.

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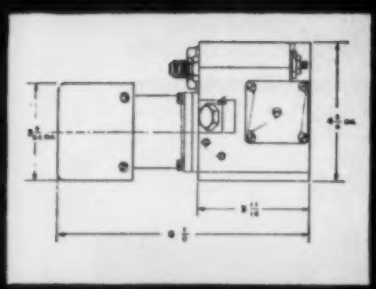
Available with either 1/8, 1/4, or 1/2 horsepower motor, in 28 V. D.C. or 400 Cycles 3 Phase power.

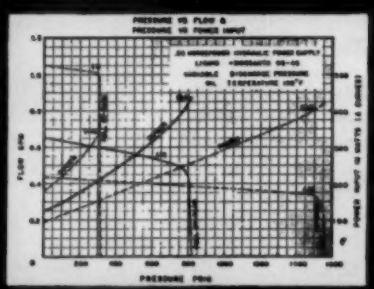
Available with various pump characteristics.

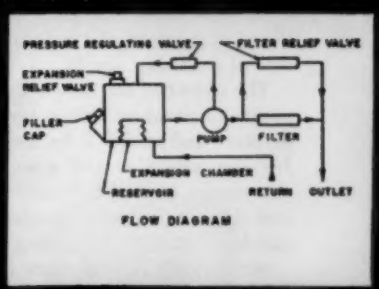
Under certain operating conditions, units can be made self-cooling. *Example:* 1/4 H.P. Unit has a continuous-duty oil-temperature rise above ambient of approximately 60 F. at sea level.

Pressure range from 0 to 1500 PSIG with compatible flow.

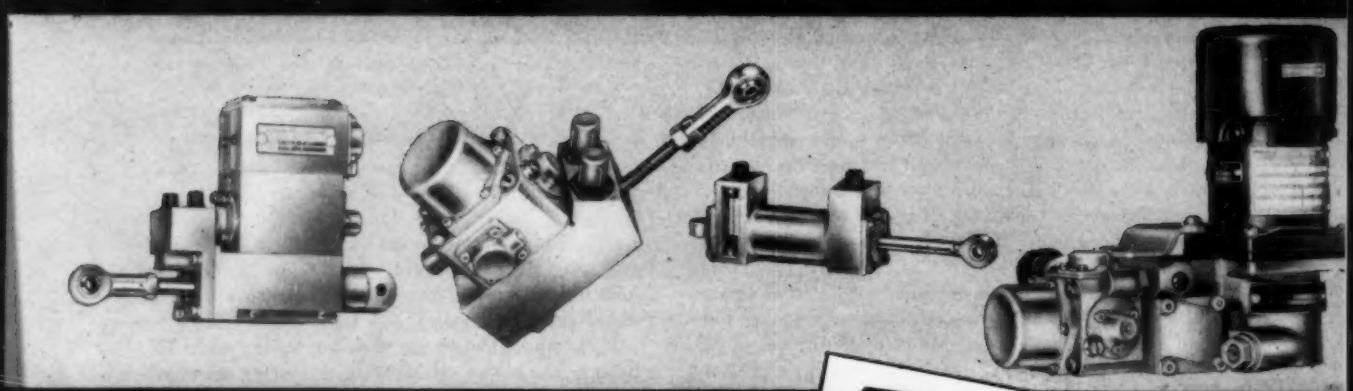
Anodized aluminum body contains all components except motor.







FLOW DIAGRAM



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and trimmed cold. The parts were annealed at 1200 F for two hours and then cleaned.

Experience taught that the forging temperature of 1550 F must be held throughout; all ductility is lost in cooling. For this reason, titanium should be forged with larger hammers to reduce the chances of cooling before completion. After the annealing operation the fittings had a file hard, invisible crust that caused considerable difficulty when machining operations began.

After machining and during assembly, threaded parts developed a brittle condition that resulted in excessive torque and thread destruction. To eliminate this chipping and galling condition due to embrittlement, all parts were immersed in a 26 percent cyanide bath at a temperature of 1480 F for 30 seconds, followed by a water quench. Previous tests of a five minute immersion to relieve embrittlement resulted in etching which decreased pitch diameters below specified tolerances. Tests were conducted at varying periods of immersion to determine the ratio of time/material loss. As a result, it was found that a 30 second immersion afforded substantial embrittlement relief while holding material loss to .00025 inch maximum, equivalent to .001 inch on the pitch diameters. This process resembles a vacuum anneal in that the parts are stress relieved at a specified temperature in an atmosphere free of oxidizing agents.

The object of the tests was to determine the suitability of titanium tubing and fittings at room temperature and at 400 F for use in hydraulic systems. Impulse, vibration and assembly tests were run in accordance with MIL-F-5509 and MIL-F-18280. MS and AN fittings were compared, using aluminum, stainless and titanium tubing.

MS and AN fittings made from titanium are definitely superior in strength and re-usability to aluminum and steel fittings. Break-away and presetting torques are below those for aluminum and steel. Repeated assembly tests show that titanium can be used considerably more times than aluminum or steel fittings. Aluminum and steel nuts will bottom on the hex flat after ten or twelve assemblies. Aluminum fittings tend to gall and strip the threads when the torques reach higher than normal. Titanium fittings fully withstand the highest torques possibly encountered in any type assembly for sizes -6 and -10.

MS titanium fittings are superior to AN titanium fittings in that high torques result in a deeper bite of the MS-21918 sleeve, while high torques in an AN fitting result in expansion of the flare, causing a wedging action against the sleeve (AN-819) and the nut. This action causes the nut to jam against the sleeve and tube, resulting in difficult rotation of the nut during assembly and disassembly. Also, high torques cause the 37 degree flare to deform sufficiently to warrant rejection. The reusability of a deformed or overtorqued AN fitting with another flare would probably be limited. In such a case, even if there is no leakage, vibration would cause the assembly to fail.

It is impractical to use titanium tubing with AN fittings due to the difficulty in producing standard flare diameters and angles. Tests indicate that machining of the tube prior to flaring is necessary. The production rate of flares on titanium tubing is fifty

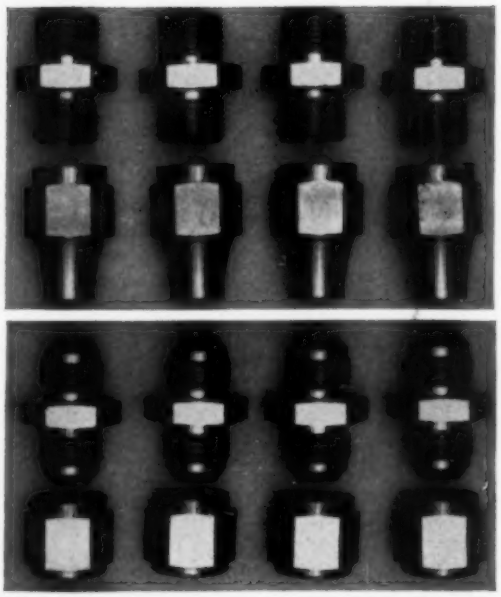


Fig. 1. MS, flareless, and AN, flared, titanium fittings are stronger and more re-usable than aluminum or steel fittings. In sizes -6 and -10 such fittings withstand the highest torques ever encountered in any type assembly. Because of flaring difficulties, the MS fittings have more applications in aircraft hydraulic systems than the AN fittings.

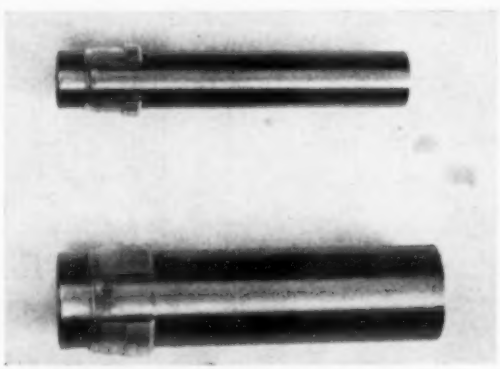


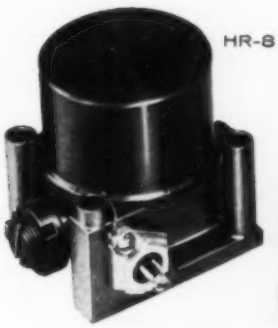
Fig. 2. A titanium tube showing the ring cut resulting from standard assembly of the MS fitting.

BENDIX-PACIFIC

HIGH RESPONSE

HYDRAULIC SERVO VALVES

GREATER NULL SHIFT STABILITY AT WIDER TEMPERATURE RANGES WITH EXCEPTIONAL RELIABILITY



HR-8

HR-9

	HR-8	HR-9
RATED FLOW:	2.5 G.P.M. at 1500 P.S.I. Press. Drop and 6 MAAI	4 G.P.M. at 1500 P.S.I. Press. Drop at 8 MAAI
GAIN:	.48 G.P.M. Per MAAI	.5 G.P.M. Per MAAI
OPERATING CURRENT:	4 MA Quiescent	4 MA Quiescent
OPERATING PRESSURE:	3000 P.S.I.	3000 P.S.I.
LEAKAGE:	.15 G.P.M. Max. (None External)	.15 G.P.M. Max. (None External)
NATURAL FREQUENCY:	235 CPS	250 CPS
DITHER:	None	None
COIL:	Concentric Double Wound.	Double Wound, Equal Resistance Windings

HR-10

HR-11

	HR-10	HR-11
RATED FLOW:	.4 G.P.M. at 3000 P.S.I. Press. Drop and 8 MAAI	4 G.P.M. at 3000 P.S.I. Press. Drop and 20 MAAI
GAIN:	.05 G.P.M. Per MAAI	.02 G.P.M. Per MAAI
OPERATING CURRENT:	4 MA Quiescent	10 MA Quiescent
OPERATING PRESSURE:	3000 P.S.I.	3000 P.S.I.
LEAKAGE:	.10 G.P.M. Max. (None External)	.10 G.P.M. Max. (None External)
NATURAL FREQUENCY:	150 CPS	160 CPS
DITHER:	None	None
COIL:	Double Wound, Equal Resistance Windings	Double Wound, Equal Resistance Windings

Write us regarding
your Servo Valve problems.

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CANADIAN DISTRIBUTORS: AVIATION ELECTRIC, LTD., MONTREAL 9 • **EXPORT DIVISION:** BENDIX INTERNATIONAL, 205 E. 42nd ST., NEW YORK 17

percent less than those on stainless steel tubing; approximately 25 percent of flares on titanium tubing must be scrapped due to cracks or irregular ovality.

When MS fittings are assembled according to recommended procedures to titanium tubing, an excellent "cut" or "bite" into the tube creates a perfect seal. Such fittings may be used without lost production time or tube assembly scrap. No rejectors were experienced with any tube assemblies made with MS fittings.

MS fittings on titanium tubing performed better than on stainless tubing in sizes -6 and -10 with respect to vibration testing. On the other hand AN fittings performed better on stainless tubing than on titanium tubing in the same sizes. A reasonable conclusion is that, during the flaring of titanium tubing, the material is weakened due to tensile and compression stresses, resulting in early fatigue failure.

In comparing titanium and stainless steel tubing, equal wall thicknesses were used. The ultimate tensile strength of the stainless was 120,000 psi, that of the titanium 92,000 psi. The differences showed up on the burst and pressure tests since tensile is in direct ratio with ultimate burst or rupture. In respect to fatigue, titanium tubing gave better results at 400 F than stainless steel. This was true for both vibration and impulse testing.

MS fittings show a superiority over AN fittings when subjected to extreme stress conditions at 400 F on both titanium and stainless steel tubing.

In addition, titanium fittings performed better than cadmium plated steel fittings on both types of tubing (stainless and titanium), both at room temperature and at 400 F.

Care must be exercised in preparing the titanium tube for flaring to prevent cracking. The best results were obtained when the tube was cut square, burred lightly on the outside diameter and radiused on the inside diameter to twice the approximate thickness of the soft layer. Microscopic examination

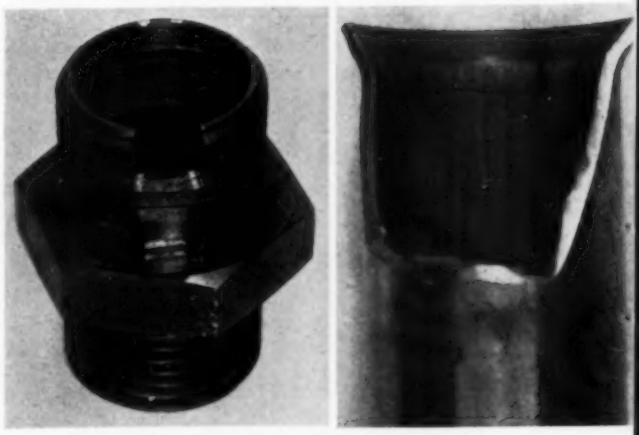


Fig. 3. Typical failures of titanium fittings. The MS (left) failure was due to high stress concentration at the weakest point. At the right is a sectioned tubing exposing a circumferential crack at its weakest point —base of flare (typical failure with AN fitting).

of the titanium tubing indicated a soft layer on the outside and inside surfaces of the tubing approximately .004 inches thick. When the inside diameter of the tube was chamfered instead of being radiused, the tubes cracked longitudinally .024 inches short of the required AN flare diameter.

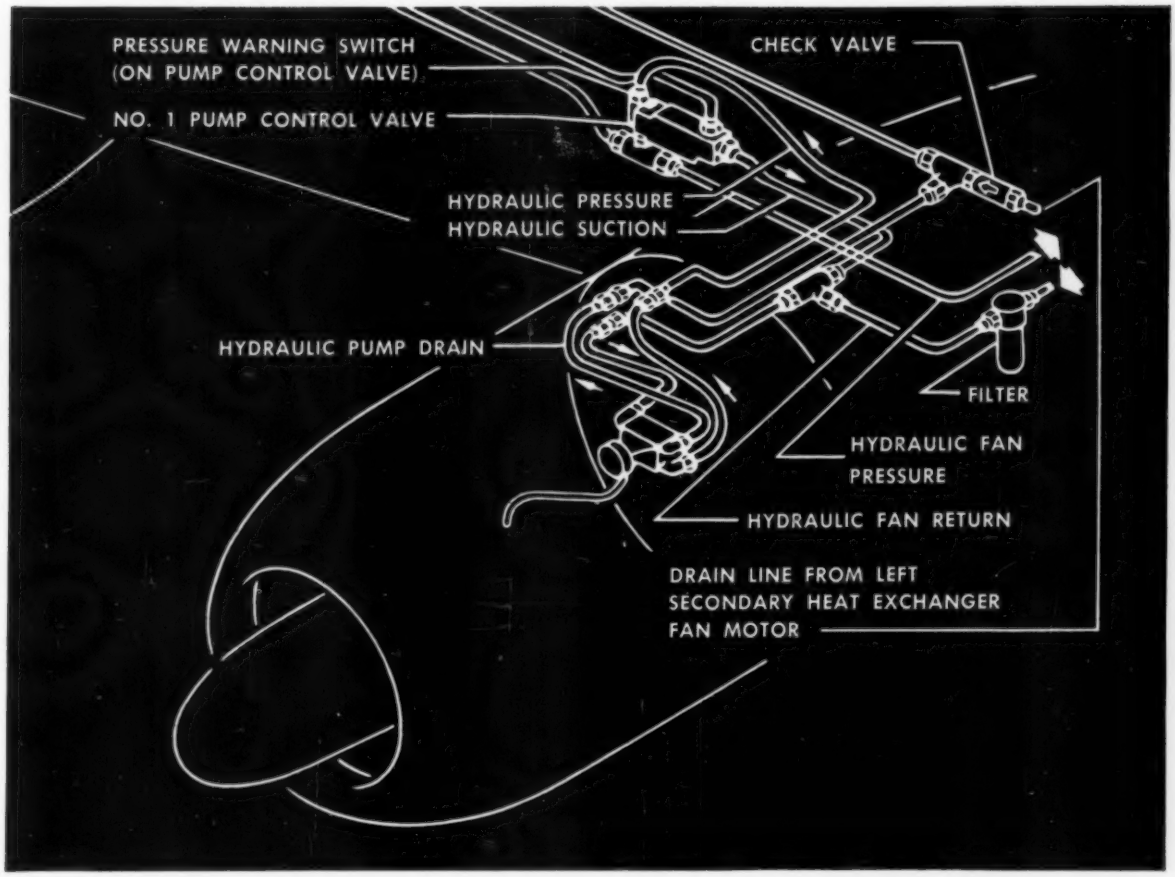
Inevitably, the question arises, "How must does it cost?" Perhaps the best answer for airframe manufacturers is to show the increase in cost per pound of weight saved. For example, if a production airplane costs $50.00 per pound with a growth factor of 5:1 (structural weight versus accessory weight), it would be advantageous to substitute a finished product weighing one pound less, as long as the excess cost did not exceed 5:1 x $50.00 or $250.00. Table I shows the cost comparison between MS and AN titanium and carbon steel fittings. The chart gives the actual cost per pound of weight saved for an MS or AN titanium fittings assembly. Table II compares stainless and titanium tubing cost. As the price of titanium decreases, the cost per pound of weight saved will also drop. ▼▼▼

Table 1. Cost Comparison between MS and AN Titanium Fittings and Carbon Steel Fittings.

Tube	Fitting	Fitting Assembly—nut, sleeve & connector						Cost/lb
		Steel		Titanium		Cost Diff	Wt Saved	wt. saved
Size	Type	Cost/M	Wt./M	Cost/M	Wt./M	$/M	lbs/M	$/lb
6	AN	$245	124 lbs	$7414	69 lbs	$7169	55 lbs	$130 lb
6	MS	$279	115 lbs	$7540	64 lbs	$7291	51 lbs	$143 lb
10	AN	$552	282 lbs	$16505	158 lbs	$15953	124 lbs	$129 lb
10	MS	$580	268 lbs	$17247	150 lbs	$16667	118 lbs	$141 lb

Table 2. Cost comparison between MS and AN Titanium Tubing and Stainless Steel Tubing.

Tube	Seamless tubing 3/8"x.025"; 5/8"x.035"						
	Stainless		Titanium		Cost Diff.	Wt. Diff.	Cost/lb
Size	Cost/Mft	Wt./Mft	Cost/Mft	Wt./Mft	per M ft	per M ft	wt. saved
6	$582	90 lbs	$3500	50 lbs	$2928	40 lbs	$73/lb
10	$801	220 lbs	$7500	123 lbs	$6699	97 lbs	$69/lb



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Ideas from a Sales Engineer

Elmer F. Heiser

Elmer Heiser has been selling air and hydraulic components for 19 years. During this time he has solved many problems and admits to leaving some unsolved. He is the author of the book "Air and Oil Cylinders in Industrial Applications."

Piques of Peddling

ONE morning, while poking along, crossing town in the morning traffic jam, I noticed the guy in the car ahead. At first it seemed that the traffic conditions were getting the best of his disposition, but then it looked more like he was engaged in a heated argument with another passenger in the car. His head was bobbing and wagging and his free hand was going through a lot of forceful motions. Whenever he turned his head to address the recipient of the diatribe it was obvious that he was jabbering away in earnest. It was far more interesting to watch him than to stare at his frequently winking stop lights, so I tried to imagine a basis for his actions. He finally turned off, still waving his arm with clenched fist, so the study ended. The peculiar thing about it was the fact that he was the sole occupant of the car, so you can see that with nothing better to do, one would naturally reflect on his problem.

The limited period of observation, extending no more than fifteen or twenty minutes, did not allow ample time to reach a definite conclusion as to the probable or possible cause of his irritation. It was impossible to see if his suit, shoes, shirt or glasses were spattered with oil, but he sure had all the earmarks of a fluid power peddler popping off. All of his actions could well have been those of the air-hydraulic salesman approaching or leaving one of his problems. It must be said that most of us possess a high degree of self-control and would not let go in public, but one of lesser mettle might well be found expressing his opinions to no one in particular.

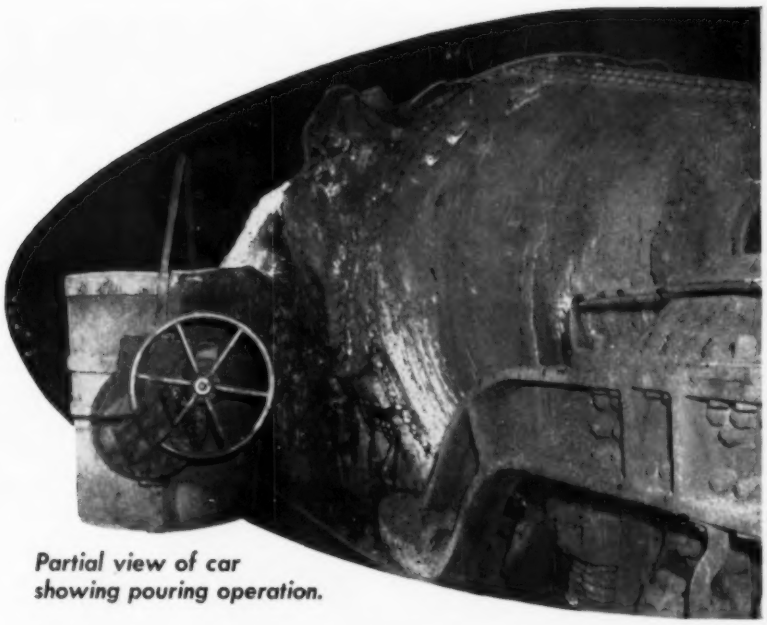
Perhaps the pet piques, peeves and problems of peddlers in this field are no different than those of the salesman or even ordinary people in other lines of activity. However to start on the assumption that our problems are as simple as others would eliminate what seemed like a good introduction, and in fact could eliminate the entire column.

So haranging and gesturing, obvious to those around, we proceed to outline some of the irks of our ilk.

The one thing that can set a fluid power fella to muttering is an obstreperous installation. The job that is all figured out, looks good on paper, and perfect at assembly, but acts up, can throw you into a spin. If it refuses to work the first time, that isn't too bad. Your initial figuring may have been correct and the arrangement worked out may still

This is a

HOT METAL CAR



Partial view of car showing pouring operation.

It contains 90 tons of molten iron which is poured into 5 ton ladles, as needed to serve a casting floor in Jones & Laughlin's Pittsburgh Works. To pour this iron from the car requires a force of 180 tons.

This operation is performed hydraulically by equipment designed and built by Benjamin Lassman & Son. The operator uses two push buttons, one for raising and one for lowering the car body. The speeds of pouring and returning are equal and independent of loading and oil viscosity changes due to temperature extremes between summer and winter. The response of the system must be, and is smooth and shock free, even on reversal of motion, and the load can be indefinitely sustained in any position.

The movement and control of large masses dictates the use of heavy duty components, and all those used here we have designed and built accordingly.

But the really unusual thing about this particular Lassman-designed-system is that the hydraulic circuit comprises only a pump and two check valves!

The simplicity and reliability of this installation is an example of the character of engineering design that is inherent in our hydraulic systems, and the high quality of our equipment is your guarantee of quality performance. We would be pleased to work with you on your hydraulic applications and to show you the advantages of control and operation that we can offer you.

A close-up of the arm engaging the car body.

Quality EQUIPMENT for *Quality* PERFORMANCE

BENJAMIN LASSMAN & SON Route 8, GLENSHAW, PA.

be a good one. You approach this type of problem firmly convinced that somebody else goofed. We had one such job involving a number of air valves and cylinders. When it was hooked up and ready to go we were called because it failed to operate. It didn't even wheeze the first time, although the shut-off valve on the line ahead of the machine was wide open. All we had to do to get things running ship-shape was to follow the air line back to the header and open a shut-off ahead of the one at the machine.

That sort of thing doesn't cause muttering and mumbling unless you had to be two other places at the same time you were playing hide-and-go-seek with a shut-off valve. Picture the kind of a job, though, that starts out well-behaved, runs five or six times in good shape and then acts up. Next time it perks for a dozen cycles and then—phooey. Or take the installation that will run okay at high speed but stumbles if slowed down or vice-versa.

This Machine Has Ears

We had one that started out a little tricky on paper. There were a couple of cylinders with a flock of pilot and interlock valves for controlling the cycle. After it was worked out on paper to everyone's satisfaction, and a test unit built, we found that it was decidedly tempermental. Believe it or not, that gadget even recognized the spoken word. We had worked with it several days, analyzing its ailments and making corrections. Late in the evening of the third day we knew we had it conquered. We tried it at high pressure and low pressure and in between, also we adjusted speed through a wide range without mishap. All of this was to be sure that it would operate properly under any conditions in the field. After perhaps an hour of testing under different conditions, we concluded that we had the bugs eradicated. All that remained was to run a time check, with one man at the control counting cycles while another held the stop watch. In order to synchronize our activity, it was decided that the fellow counting cycles would yell when the required figure was reached so the clock watcher could stop the watch. Feeling smug, satisfied, and perhaps a little silly the guy yelled "WHEN!" This was supposed to be funny, and did get the watch stopped, but at the exact instant he yelled, the orderly sequence let go into a melee of erratic motions which had everybody grabbing everything to shut things down before destruction set in.

Why would a machine mislead by behaving perfectly for hundreds of cycles for an hour or more and get tempermental because somebody said "when." It was too late, too dark, and too foggy going home that night to see well, but had I been driving behind my car I probably would have noticed the fellow ahead doing unusual things.

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Whatever your restrictor requirements, chances are Gar already has units with the characteristics you're after. Gar hydraulic and pneumatic restrictors come in one-way and two-way types, and just about every other type, size and rating you can imagine. But, should you ever ask for special characteristics in pressure, flow, weight, temperature or envelope size that aren't standard at Gar, you'll never know, because we'll produce what you need in the same short delivery time, at the same low price.

Some extras that might interest you, too, for special applications are self-cleaning designs that work, and electroformed orifices that are unique for highest precision and absolutely identical flow characteristics.

But right now, the important thing is to call Gar. After that, you can leave the rest up to us.

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Besides the occasional activities of inanimate objects which tease and baffle, there are some rare characters who pique us peddlers. It must be pointed out that the word rare is used in its true sense, they are few and far between, nevertheless when encountered they present a problem. High on the pique parade would be the fellow who is a bargain shopper. He answers his current problems by picking up discarded used equipment. He will buy a piece of machinery that was built years ago, with a crust of corruption on it thick enough to shovel, then yell for the representative of any fluid power part hung on it. This guy knows little or nothing about air or hydraulic equipment. He bought a pig in a poke, but if he can identify a valve, pump, cylinder or other part, he sees succor on the way. (By any other spelling it sounds the same). He now expects the representative to extend to him the service which he is entitled, which includes checking the equipment, explaining its operation and furnishing day and night telephone numbers where he can be reached in case of emergency. The notion prevails here that somehow the timely rescue of machinery from the junk heap forms a binding obligation on the part of the component equipment suppliers to keep it in operation.

Small Sale, Big Problem

Somewhat akin to the fellow who buys an old machine, with your unlucky number on it, is the chap who builds a new machine with one or two of your components on it. Although that which you furnished may be a drop in the bucket comparatively, it somehow becomes in his mind the heart of the whole thing. Any failure of the new machine to perform as expected is laid at your door until you prove otherwise. It may take hours to determine that excessive friction, or binding in mechanical members is the cause of the trouble. A relay that acts up or a short in the wiring are sure indications to this fellow that your little old unit isn't doing what it oughta.

Another pet among peeves is the adjuster. He's the fellow who

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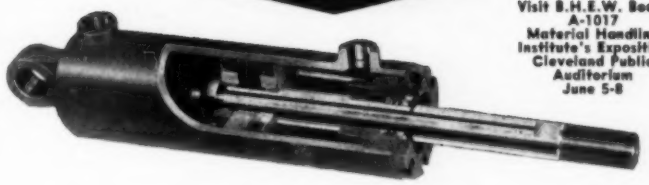

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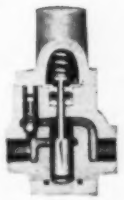

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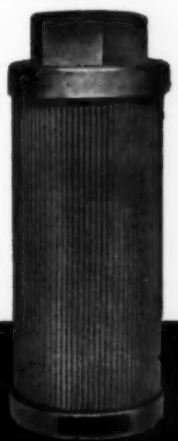

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has an irrepressible itch to adjust any thing that looks adjustable. He doesn't know what all the adjustments are for, but figures that he can improve the whole operation with a little fiddling. We re-

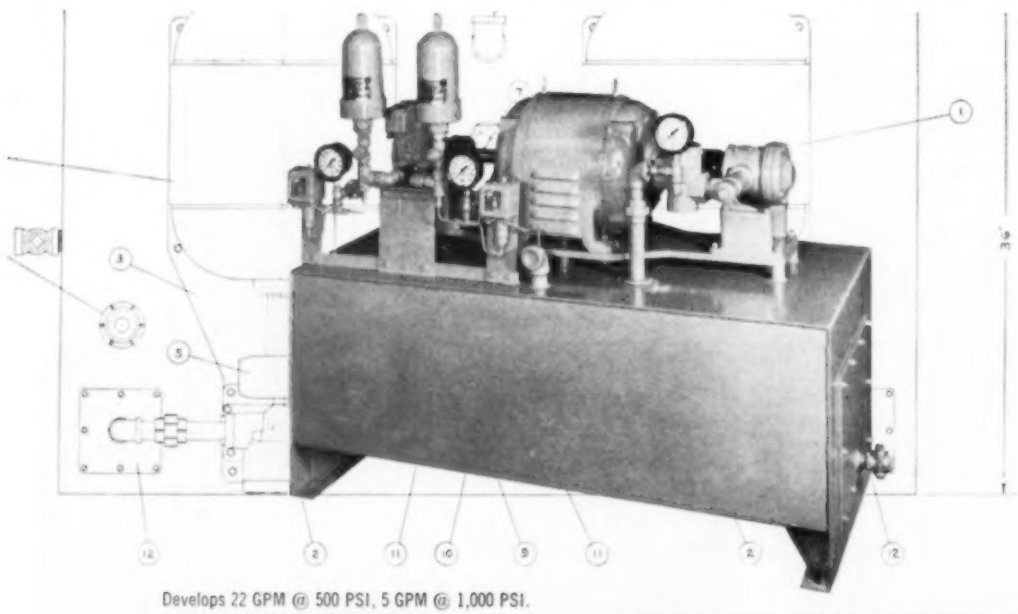
. . . knob happy fellows are a big help . . .

call one hurry up trip halfway across the state in answer to an urgent call from management. A machine, necessary to production, had ceased to function and the trouble definitely was traced to our equipment. Five minutes time with a screw driver and a crescent wrench fixed them up. In spite of the fact that "positively no one had touched anything", a couple of screws were backed out to new settings and the lock nuts retightened. Imagine driving back 150 miles explaining that to no one in the seat beside you. Another rare but mutter-making predicament could be called cross-fire. This happens when the peddler gets caught in the sniping between individuals or departments in an organization. He starts working with one group, perhaps on the design of the equipment, and ends up with the installation or maintenance gang. One group is sure that the others are not very bright and look for opportunities to prove it. If they can get the salesman to even nod his head during their presentation of one side of an argument, they are happy; but he may be cooked.

Squeezed in the Middle

A similar but more deadly crossfire develops at times when an account in your territory receives a machine built in some other part of the country. When, and if any trouble develops involving equipment furnished the original builder by your factory, you may be asked to service the job. The purchaser may have decided that he bought a pile of trouble and you may be inclined to silently agree. He may ask for your opinion on the application suggesting that the trouble is due to a misapplication. Maybe so, but you must give him service not ammunition. The fellow in the car might have been figuring a way to help out in such a situation without his action or inaction being construed as criticism somewhere along the line.

By this time your tears of sympathy for the poor peddlers are probably messing up the whole magazine spoiling otherwise good reading. Come to think of it, the whole thing has been a mistake, that unfortunate fellow carrying on by himself in the car acted more like one of my fishing friends who has mother-in-law trouble. He puts all the same gestures in and keeps it up even when we stop listening. ▼▼▼



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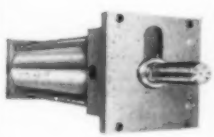

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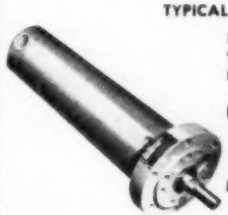
Slide Cylinders
Die Casting Shot Cylinders
Drilling & Tapping Machines



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SERIES S—Air or Low Pressure Hydraulic Extra Heavy Duty Automation Cylinder

TYPICAL APPLICATIONS

Clamping Fixtures
Welding Machines
Automation Equipment
Loading & Unloading Devices

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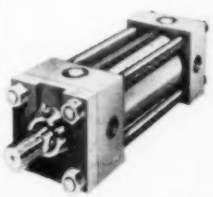
SERIES N—High Pressure Hydraulic Heavy Duty Cylinder

TYPICAL APPLICATIONS

Feed Cylinders
Welding Machines
Die Casting Machines
General Machine Tools



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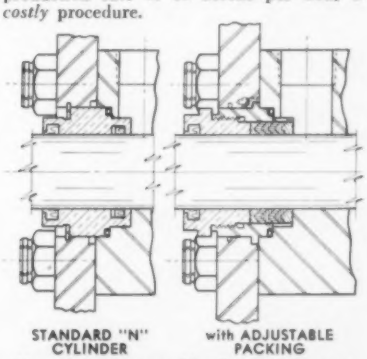
The ENGINEER'S Corner

As an engineer I am well aware of the importance of flexibility and problems brought about by continuing change which reach my department regularly. Our best answer to change is achieved through interchangeability. We are meeting this challenge by interjecting flexibility in our line wherever possible.

Recently we were confronted with this problem of interchangeability on a large scale in a line of transfer machines for processing V-8 engine blocks for a large automotive manufacturer. The machines were designed by several large machine tool manufacturers to conceive all possible production space which meant that the hydraulic cylinders in a majority of the cases would not be mounted in easily accessible locations.

As a result when a severe leak showed up in a cylinder and it failed to maintain pressure the customer knew he would be faced with considerable downtime for cylinder removal and repairs. In some inaccessible locations as much as 8 to 10 hours would be involved. This would mean production stoppage of an entire shift and based on a production rate of 60 blocks per hour a *costly* procedure.



STANDARD "N" CYLINDER — with ADJUSTABLE PACKING

How Hydro-Line provides for interchangeability of Adjustable and Non-adjustable packing in Standard N Cylinders.

The natural solution would be a cylinder on which slow down or repair of a leak could be made until scheduled maintenance could make permanent repairs.

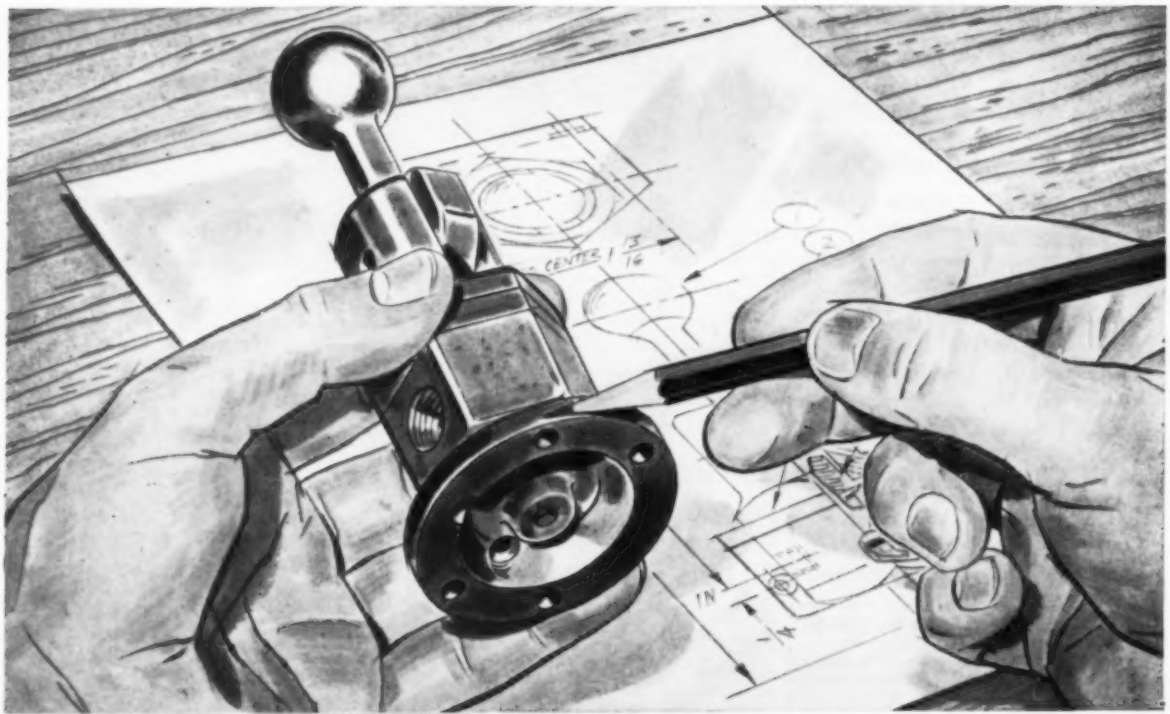
Along with other cylinder manufacturers we were asked to submit our solution. Our proposal was selected because it answered effectively the problem of adjustable packing and equally important because of the interchangeability provided through use of our standard N cylinder.

Our solution was to take our standard N cylinder with non-adjustable packing and equip it with a threaded gland packing retainer. By merely replacing bushings the customer could convert the cylinder from non-adjustable to adjustable packing or vice versa. It enabled the customer to take up the rod packing while the cylinder was still on the machine, stopping small leaks around the piston rod and executing temporary maintenance with complete safety until permanent maintenance could be achieved between shifts. Our standard N cylinder with non-adjustable packing and the converted N with adjustable packing were interchangeable even to end caps and follower. The problem was solved and interchangeability achieved to the complete satisfaction of the customer.

Joseph L. Bosi

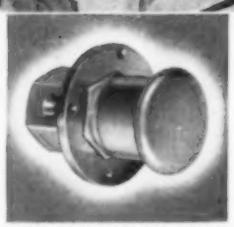
Hydro-Line Manufacturing Co.
Chief Engineer

Simplified design . . . versatile mountings . . . distinguish new MAC pilot valves



NEW HAND VALVE—available in either locking or non-locking type. May be used singly or in series for working pressures up to 150 P.S.I.

NEW FOOT VALVE — small and compact, has adequate treadle area. Anchors easily.



NEW PALM-BUTTON VALVE —suitable for panel mounting. Returns to normal position.

NEW SOLENOID VALVE — instant action. Protective cover is easy to remove.

NEW CAM VALVE—built-in overtravel prevents damage when operated by cam series.

Design makes the difference in these pilot valves. And it's easy to spot. MAC's new pilot series is trim and compact. The valves are lightweight, and smaller . . . have fewer parts. By simplifying design, MAC engineers virtually eliminated maintenance . . . built in dependability for millions of cycles.

You'll find MAC pilot valves tops for convenience, too. A variety of mountings mean they can be installed almost anywhere—close to hand or foot, or overhead and out of the way. And, of course, this new pilot series reflects the precision and quality workmanship that mark *all* MAC valves.

So, look to MAC for *all* your air valve needs—solenoid, pilot operated *and* pilot . . . any size or type. We've got the answer *—and exactly the right valve—*for any air control problem. Write us or contact a representative listed at the side.

MECHANICAL AIR CONTROLS, INC.

Office and Factory—10030 Capital, Oak Park, Detroit 37, Michigan

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CHICAGO 43—Mike C. Modrich & Co., 10336 South Western Ave., Hilltop 5-3640

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MECHANICAL AIR CONTROLS, INC.
DETROIT 37, MICHIGAN

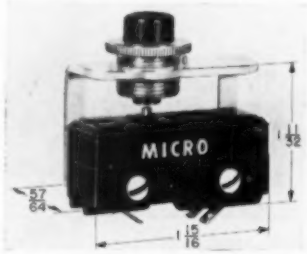
MAC

New Products continued

PUSHBUTTON ACTUATORS . . . for snap switches

Designation: 4MA, 5MA Series

Design: Actuators combine an attractive appearance with long life. Buttons of both ½ and 1-inch diameter are available in red, green, or black plastic. The snap-action



operation of the assembled switch and the relatively high pretravel of the actuator give an exceptionally good "feel" to the push button switch assembly. The high pretravel also prevents accidental operation of the actuator. Many different types of basic switches can be used with the actuators, including hermetically sealed switches, high capacity switches, double-pole double-throw switches, and magnetic blow-out switches.

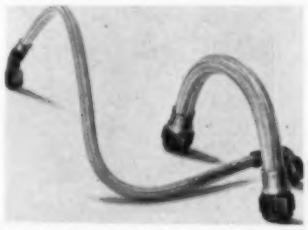
Micro Switch Div.,
Minneapolis-Honeywell Regulator Co.
Freeport, Illinois

Circle 188 on Reader Service Card

PREFORMED AIRCRAFT HOSE . . . of Teflon

Designation: Preformed Fluoroflex-T R3800

Features: Factory preformed hose assemblies are permanently formed



to clear obstructions and make connections in the shortest possible length. Factory process permits smaller bend radii with minimum restriction of inside diameter when compared to un-preformed assemblies. Stress is eliminated in the critical bends; and neat, efficient plumbing design is possible with the elimination of special elbows. Hose has ambient temperature range of −100 to +500 degrees F and pressure range to 1000 psi. It is inert to all known oils, fuels, and propellants, and has been approved by the Armed Services and CAA.

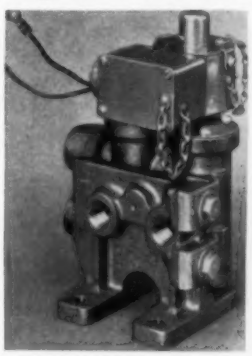
Resistoflex Corp.
Roseland, N. J.

Circle 189 on Reader Service Card

4-WAY SOLENOID VALVE . . . for 150 psi

Designation: Crescent

Design: Solenoid is inoperative when its cover is removed, and there is a manual override which prevents accidental actuation. Conduit connector is threaded and pressure ring terminals are on 6-inch



free leads. Solenoid and junction box are protected by captive cover plates which seal them against contamination. Valve can be quickly removed from sub base by loosening three body clamps.

Features: Pressure drop is reduced because the free port area approximates the pipe area. JIC solenoid is completely interchangeable with standard solenoids, and valve can be converted to any practical current or voltage by changing coils. Coil burnout is eliminated by short-stroke, pilot operation and large power margin.

Barksdale Valves
Los Angeles, Calif.

Circle 190 on Reader Service Card

Continued on next page

Circle 71 on Reader Service Card

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BRITISH

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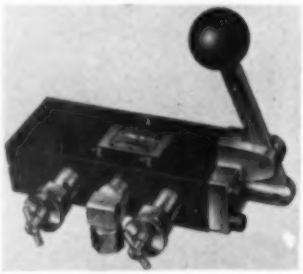
New Products continued

AIR THROTTLING VALVE

. . . mounts in control valve port

Designation: Model 500

Features: Speed control valve is precision machined from non-corrosive brass bar stock and parts are



permanently assembled. The adjustment screw cannot be blown out. No tools are required for flow adjustment, the needle valve can be adjusted and locked by hand.

Installation: Valve screws into either or both exhaust ports of a 5-port 4-way valve to provide speed control of an air cylinder in one or both directions. Installation in exhaust port of a 3-way valve regulates return speed on a single-acting cylinder. Unit is available in ¼, ⅜, and ½ NPT pipe thread sizes.

Modernair Corp.
San Leandro, Calif.

Circle 191 on Reader Service Card

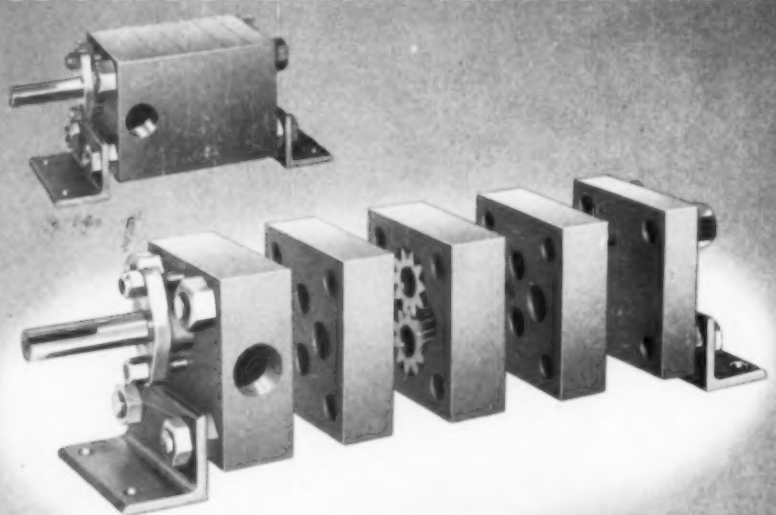
EXPLOSION PROOF MOTORS

. . . for gas, dust locations

Construction: All steel parts of motors are dipped in special moisture resistant material, baked, and then painted. Finished rotors are sprayed with special rust inhibitor which covers the rotor and entire shaft. Terminal box is gasketed and leads are sealed at both the motor shell and the outer shell. Repellent grease in the shaft extension end keeps moisture away from the bearings. Several layers of impregnated

Continued on page 140

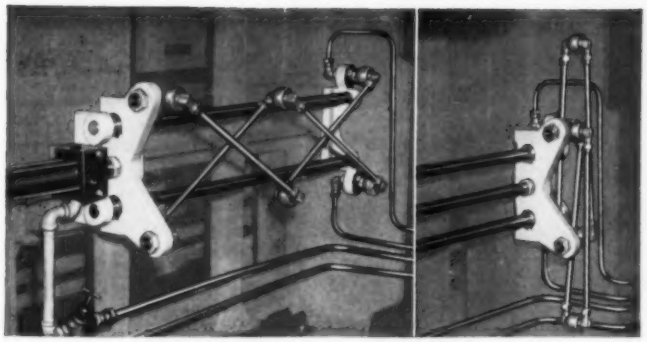
NORTHERN NITRALLOY PUMPS



The unique block construction of Northern Nitralloy Pumps offers the widest choice of materials for its functional elements.

Nitralloy, nickel cast iron, bronze and stainless materials combine in an unusually functional design with precision manufacturing methods to pump liquids from propane to adhesives and liquid CO_2 to molten lead. For information write for free catalog and specifications.

NORTHERN ORDNANCE INCORPORATED
Subsidiary
NORTHERN PUMP COMPANY
Minneapolis, Minnesota



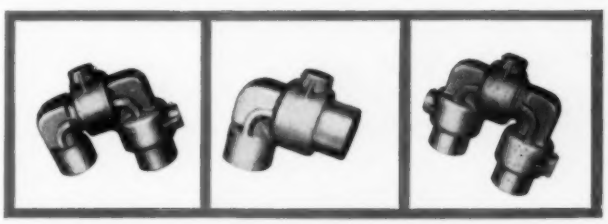
Chiksan Swivel joints, with full 360° rotation allow duplicate sets of lines (left) to be compacted into small spaces (right).

PROBLEM: EXTREME BEND RADII

SOLUTION: **CHIKSAN SWIVEL JOINTS**

Got a bend radii problem? Then let Chiksan engineers go to work on the answer. Chiksan has the years of experience and know-how to handle your problem quickly, efficiently.

Chiksan Swivel Joints provide unlimited flexibility in a compact package to meet your exacting pressure and temperature requirements. Be it for air, hydraulics, fuel, oil, water or other fluids, it will pay you to have Chiksan provide the right swivel joint for *your* bend radii problem.



Typical Chiksan Swivel Joints

FOR FREE CATALOG WRITE DEPT. 15-5

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A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

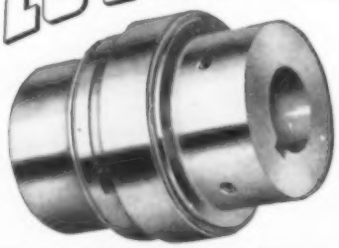
CHIKSAN COMPANY— BREA, CALIFORNIA • CHICAGO 3, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Chiksan of Canada, Ltd., Edmonton, Alta.

15 YEARS SERVICE WITH ONE SET OF CUSHIONS

...actual report on

LOVEJOY



Flexible Couplings

Up to fifteen years maintenance-free service is not unusual with Lovejoy lubrication-free flexible couplings.

Performance like this is practical proof of these soundly engineered features:

SIMPLE, RUGGED CONSTRUCTION
Fewer parts. No intricate mechanisms. Nothing to lubricate.

LOAD TRANSMITTED BY CUSHION COMPRESSION
No wear on the metal jaws.

DOUBLE-LIFE CUSHIONS
One half of the cushions act as idlers—except on reversible loads. A quick interchange provides a new set of cushions. This can be done without dismantling the coupling.

Illustration at right shows a Lovejoy Type CF flange-mounted coupling. Rated at 160 hp., 800 rpm., this space saver connects drive shaft between diesel power unit and generator.

You can get Lovejoy performance for your application.

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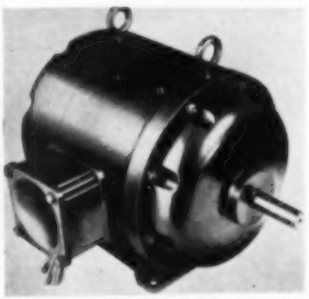
Mfrs. of Flexible Couplings, Variable Speed Pulleys and Transmissions, Motor Bases and Universal Joints.

New Products continued

papers are used in the slots and between phase groups. Entire winding is pre-heated and successively dipped in synthetic resin-base varnish and baked. Ball bearings are



fully-sealed and prelubricated. Double-row bearing race width furnishes increased contact area with the shaft and housing and provides an extra large grease reservoir. Motors smaller than frame 254 are totally enclosed, non-ventilated. Finned brackets replace fan-cooling in dissipating heat. Explosion proof motors are available in new NEMA Standard sizes.

Sterling Electric Motors
New York, N. Y.

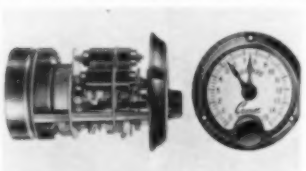
Circle 192 on Reader Service Card

TIME DELAY RELAYS

. . . have increased accuracy

Designation: Types 412, 422

Features: Time delay relays have about twice the accuracy of previous models. Full vision, white-on-black dial with 300-degree scale allows



fast precise settings. Silver cadmium contacts are rated at 15 amp and have quick-make, quick-break wiping action. Nine-position terminal block permits easier wiring from side or back with wider range of circuit possibilities than before. Friction setting mechanism allows adjustment even while timer is operating. Electrical life is over one million operations.

Operation: Type 412 automatically resets on power failure and begins a complete new cycle when service is restored. Type 422 timer includes a special reverse action clutch which causes it to stop operation in case of power interruption, resuming and completing the same cycle when service is restored.

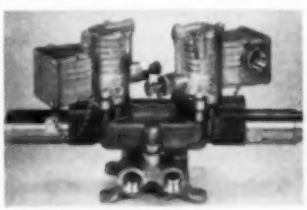
R. W. Cramer Co., Inc.
Centerbrook, Conn.

Circle 193 on Reader Service Card

VALVE CENTERING ATTACHMENT

. . . contains no springs

Features: Power-centered neutral attachment for double solenoid valves consists of stop plungers in extensions mounted at the ends of the valve body, and uses air to provide positive mechanical centering of the main valve stem in neutral position. Completely self-contained within the valve assembly, attachment operates without the use of



mechanical springs on the main valve stem. Because it provides a positive mechanical stop at neutral and has no springs to weaken or break, the new attachment will not allow the main valve stem to drift out of neutral. Valve may be mounted in any position. Teflon shock pads in valve end caps cushion stem and stop plunger travel. Attachment kit for company's valves consists of two valve body extensions with stop plungers plus a special main valve stem.

Valvair Corp.
Akron, Ohio

Circle 194 on Reader Service Card

FEED CONTROL OIL CYLINDER

. . . for air cylinder control

Designation: Hydro-Feed

Application: Simple, leakproof oil cylinder is attached to an air cylinder for 0 to 4 inches of rapid approach followed by infinitely var-

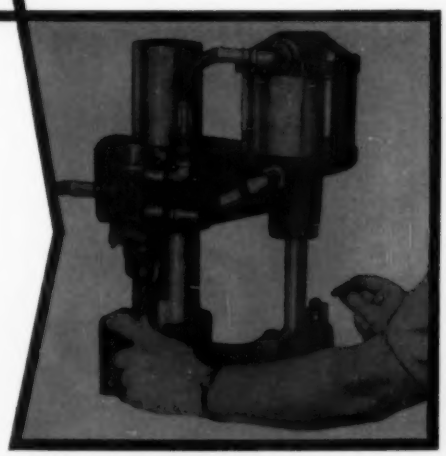
Continued on page 142

TWO-BOLT CLAMPING adjusts easily, positively from 0" to 7" in height, and swing arc 2" each side of center.
HEAVY-DUTY CYLINDER with extra heavy wall, tie rods and piston construction for longer life.
RIGID STEEL COLUMN and rugged cylinder bracket are accurately machined for precision work.
HEAVY, RUGGED BASE forms sturdy foundation for large machined-surface table area.
SPECIAL RECESS IN TABLE provides for punch-through operations.

NEW SCHRADER AIR PRESS

It's compact and power packed!

It stamps, coins, broaches, rivets, stakes, presses, shapes, bends, assembles—*many other uses!*



Modern "muscles" of compressed air never tire . . . get more work done at less cost!

This modern Air Press has unlimited possibilities for speed, power, positive performance. Available as single acting for impact jobs; double acting for squeeze and power withdrawals. It requires minimum space, next to no maintenance, is extremely versatile in adapting to operating controls. Can't be beat for low cost practicality.

Important feature: Control and speed of the extra heavy cylinder and ram can be varied as necessary, by using standard Schrader Air Control Accessories that adjust in seconds.

Write for Catalog data describing Air Press fully—including variety of controls, accessories and prices. You'll be surprised at the low prices!

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456 Vanderbilt Avenue, Brooklyn 38, N. Y.

Schrader®
ESTABLISHED IN 1844

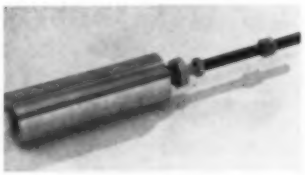
LEADERS IN AIR CONTROL SINCE 1844

Circle 132 on Reader Service Card

New Products / continued

iable feed in one direction and rapid return in the other direction. Longer strokes and pressures higher than 3000 psi can be supplied.

Features: Basic unit has microhoned 2-inch bore and 4-inch hydraulic feed stroke. Cylinder is installed by mounting nose through a ⅞-inch hole and tightening nut. Completely sealed unit requires no



make-up fluid or expansion chamber. Turning the piston rod by hand in either direction gives infinitely variable feed. Length of rapid approach is varied by adjusting two check nuts on the threaded rod.

Rotafeed Co.
Detroit, Michigan
Circle 195 on Reader Service Card

SOLENOID VALVE . . . 0-5000 psi

Designation: Model 40 Series

Features: Line of pneumatic and hydraulic 4-way valves features low

current drain, continuous duty, fast operation, explosion-proof enclosure. Temperature range is —65 to +275 degrees F and flow rates are to 10 gpm. Tube sizes from ¼ to ½ inches are available.

Mar Vista Engineering Co.
Los Angeles, California
Circle 196 on Reader Service Card

FRACTIONAL HP MOTORS . . . slip ring type

Features: Slip ring motors offer variable speed and step-by-step starting in ¼, 1/3, ½, and ¾ hp ratings in No. 66 frame. Motors

are available with speed selections from 50% to 100% of full load. 1800-rpm motors are available in ¼, 1/3, ¾, 1, and 1½ hp ratings. 1200-rpm motors are available for all but 1½ hp rating.

Reuland Electric Co.
Alhambra, California
Circle 197 on Reader Service Card

Continued on page 144

unfailing protection

For aircraft hydraulic lines and components. For fourteen years, Tubing Seal Cap's metal closures have been the accepted standard in protecting hydraulics during handling, shipping and storage.

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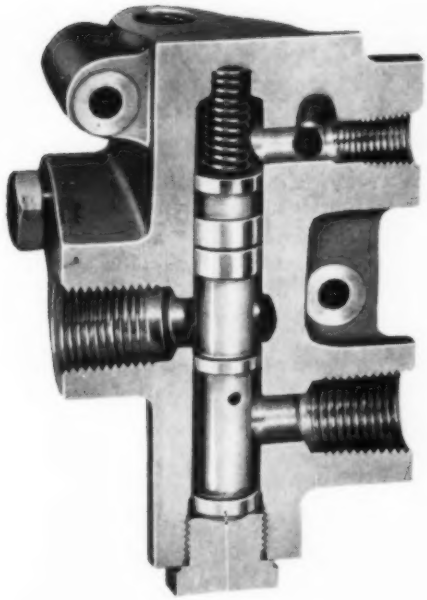

NEW Webster Flow Divider

THE MOST ECONOMICAL ANSWER FOR POWER STEERING

and other dual applications

WEBSTER'S NEW FLOW DIVIDER is a specially developed flow control valve specifically designed to provide the utmost economy in power steering and other applications where two separate hydraulic power circuits are to be served. It has been used with great success on agricultural equipment, road-building machinery, materials-handling equipment, and for many other purposes. Its advantages include:

Greatest Economy • Use of the Flow Divider eliminates any necessity for a second hydraulic pump and driving medium—cuts equipment and installation costs substantially.

Less Hydraulic Piping • Use of the Flow Divider simplifies and reduces the amount of hydraulic piping required, since it eliminates the inlet piping which would be required for a separate pump, and it can be installed close to the secondary demand.

Flexibility • The Flow Divider can be installed remotely from the pump, thus providing greater flexibility in the design of hydraulic circuits.

Compactness • The small size (2″x 3″x 5½″) of the Flow Divider eliminates installation problems.

In most applications the Flow Divider is adjusted to provide constant flow to the secondary system. For example, in power steering applications 2½ gpm are constantly diverted to the steering circuit. However, Flow Dividers can also be adjusted to allot pump capacity proportionately between primary and secondary circuits.

The Flow Divider has a capacity of up to 20 gpm at 2000 psi. A built-in damping device prevents noise, eliminates "hunting" effect. It can be provided with a built-in relief valve, if desired.

TANDEM PUMP COMBINATIONS

For those dual applications where you want two pumping units, Webster's Tandem Pump Combinations provide an economical, completely dependable answer. Rated at 1000 psi and 1750 rpm, these combinations are provided with a capacity range for the larger pump from 4.8 to 29.0 gpm. The small pump has a capacity range from 1.0 to 4.0 gpm.

Write today for complete information

AH-5

- ☐ Please send us complete information on Webster Flow Divider
- ☐ Please send us complete information on Tandem Pump Combinations
- ☐ Please send catalog on complete Webster line

Name_____

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Company_____

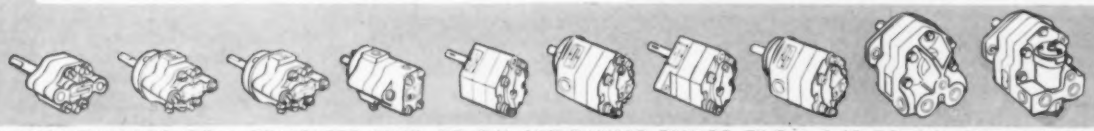
Street_____

City, Zone & State_____

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

RACINE • WISCONSIN



MANUFACTURERS OF A COMPLETE LINE OF OIL HYDRAULIC PUMPS FROM 1/5 TO 30 GPM CAPACITY

Keep YOUR HYDRAULIC SYSTEM Clean with HILCO HYDRAULIC OIL FILTER

- No More Varnish and Sludge Deposits
- No More Flushing and Manual Cleaning
- No More Frequent Oil Changes
- No More Accumulation of Dirt

Filter life up to a year eliminates usual frequent draining, refilling of systems.

HILCO Hyflow Oil Filters trap dirt, acids, rust, sludge, gums, resins . . . all solid contaminants, and keeps your hydraulic system clean and in top running condition at all times. To you, this means longer oil life, reduced wear and abrasion . . . hence, less down time and lower maintenance costs giving you continuous equipment operation with increased production. Hydraulic unit sensitivity depends upon a clean system. HILCO Hyflow filters remove solids as soon as they enter the system and retain much of the moisture which enters the oil from the atmosphere and from condensation. Obtain the full capacity and economy of your equipment by keeping it in top running condition with HILCO. Hydraulic Oil Filters come in stationary or portable models. They can be hooked into hydraulic systems without interrupting equipment operation.

HILCO
OIL RECLAIMER
For complete oil reclaiming. Removes solids, acids and volatile impurities; moisture, solvents, gasses, etc., from hydraulic fluids by heat-vacuum process.

• SEE FOR YOURSELF HOW HILCO keeps your Hydraulic System Clean . .

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THE HILLIARD *Corporation*

148 W. FOURTH ST. • ELMIRA, NEW YORK

IN CANADA:

New Products / continued

SHUT OFF VALVE
. . . is pressure operated

Designation: Model AV

Features: Valve has only one moving part and features simple, compact, lightweight construction.

Valve for 1-inch tubing is 5 inches long and weighs 1 lb. The unit handles a flow of 50 gpm at a 50-psi pressure drop. Maximum working pressure of the valve is 3000 psi and required piloting control pressure is equal to the working pressure.

Perry Valve Corp.
Dover, New Jersey

Circle 198 on Reader Service Card

AIRCRAFT PUMP MOTOR
. . . internally geared

Designation: Type GA

Design: Motor weighs 28 lb and delivers 11.5 hp at 2450 rpm. Unit is self ventilating and designed for perfect balance with the mounted

pump. For intermittent duty only, the motor delivers 11.5 hp for 10 seconds and 1.5 hp for 170 seconds. It operates on 3-phase, 400-cycle alternating current at altitudes to 25,000 ft. Starting torque is 45 ft. lb.

U. S. Electrical Motors, Inc.
Aircraft Division
Los Angeles, Calif.

Circle 199 on Reader Service Card

Continued on page 146

Circle 30 on Reader Service Card

What a sight!

CENTURY'S

All-new Oil Level Sight Gage

- No Easier Installation Ever Designed
- Better Visibility at any Height
- Leak-proof—No Dripping
- Streamlined Modern Appearance
- Important Savings in COST
- Available NOW From STOCK

Inquire today . . . make immediate use of the sensational advantages in cost and services offered by this new gage . . .

CENTURY HYDRAULICS, INC.
7701 LYNDON AVE. • DETROIT 38, MICHIGAN
Telephone: DIAMOND 1-3797

NOW THERE ARE 4 TYPES OF BELLOFRAM PISTON SEALS

Class 1 Flangeless Bead Type
Class 2 Flange Type Narrow Convolution
Class 3 Beaded-Flange Type
Class 4 Flange Type Standard Convolution

Bellofram long stroke, constant area diaphragms are now available in *four* designs, for efficient use as piston seals in countless types of pressure-sealed mechanisms. Class 1 permits design and manufacture of smaller, lighter, lower cost mechanisms. Class 2 is specially suited to high pressure applications and limited to sizes under 2½". Class 3 allows parting surfaces at flange joint to form a metal to metal joint. Class 4 is suitable for instruments and machines having natural parting surfaces between cylinder and mating metal surfaces.

Bellofram seals are available in any of 300 standard sizes; for 1" to 6" bores; in numerous elastomer-fabric combinations from Nitrile Rubber and Nylon to Silicone Rubber and Dacron. Choice is wide, design and operating advantages many. Outline your needs in confidence.

Have you a copy of the NEW 16-page Bellofram Catalog? Write today.

Bellofram
CORPORATION
BURLINGTON, MASS.

Circle 18 on Reader Service Card

OK

CUSTOM MOLDED

TEFLON

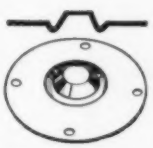
(DU PONT TRADEMARK)

IN THIN SECTIONS AND SHAPES . . .

CAN IMPROVE PRODUCT PERFORMANCE AND CUT REPLACEMENT COSTS

TEFLON is not a substitute for rubber, leather, or other sealing materials . . . TEFLON is in a class by itself, and there is no substitute for quality and performance.

TEFLON has a combination of chemical, electrical and mechanical properties unmatched by any other single material. Such characteristics as chemical inertness, resistance to corrosion, high heat resistance, toughness, high dielectric strength, low co-efficient of friction offer you design and product-improvement opportunities never before possible.



To evaluate "Teflon" for your own use . . . without cost or obligation,

SEND FOR FREE BROCHURE—
"SPARTA REPORTS ON TEFLON"
Dept. AH

The First Cost Can Be the Least . . . If It Is The Last Cost!

IMPORTANT!
As an added service to YOU, Sparta can now fill your requirements for
TEFLON
FLEXIBLE THIN WALL
& SPAGHETTI TUBING

SPARTA MANUFACTURING CO.
DOVER, OHIO
Phone: 4-2755

Circle 137 on Reader Service Card

New Products continued

ROTARY SOLENOID

. . . provides 12 in-lb torque

Designation: 400 Series

Specifications: Sixty-cycle a-c rotary solenoid provides maximum

torque in minimum space and operates on standard voltage with low power consumption. Continuous and intermittent duty types are available for 20, 30, 45, or 60 degrees maximum rotation. Intermittent duty (40% on-time) model gives 12 in-lb torque at 115 volts. The solenoid operates in approximately .020 seconds.

Construction: Totally enclosed unit offers complete environmental protection. Class H insulation and material permit high temperature, severe duty service. Bearings are solid bronze and shaft is high carbon steel.

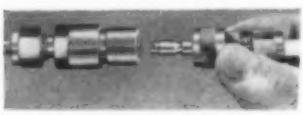
Leetronics, Inc.
Brooklyn, N. Y.

Circle 200 on Reader Service Card

QUICK CONNECT FITTING

. . . for plastic, metal tubing

Performance: Fitting incorporates shutoff valve which acts as



positive seal to prevent leakage during connecting or disconnecting operation. Internal design allows freer flow, and exterior design is slim and streamlined. Strong, torque-free, leakproof seals are provided at all tube connections.

Application: Used with plastic tubing and metal tubing, fittings are available in all metals and sizes to fit ordinary applications. Three types are for connections of tube to tube, tube to pipe, and bulkhead, either tube to tube or tube to pipe.

Crawford Fitting Co.
Cleveland, Ohio

Circle 201 on Reader Service Card

AIR VALVE

. . . for various actuations

Designation: Quick-Dump

Features: Basic valve body can be adapted to solenoid, cam-operated, palm button, finger-tip, foot operated, and hand lever actuation. Valve may be either normally open or closed depending upon port connections. Opening, closing, and holding action are effected by pressure of air or liquid, and valving action works with the pressure. A momentary electric impulse triggers the valve to open or close positions. No current is required to hold. A new type double coil, impact solenoid has been developed for the

5100 Series Relief Valve. In-line design. Gas or liquid to 1000 psi.
200 Series Check Valve. For almost any service — gas or liquid up to 3000 psi.

Send for Information Today CIRCLE SEAL *precision valves*

JAMES-POND-CLARK

2181 East Foothill Boulevard, Pasadena California

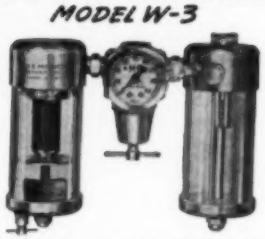
Circle 78 on Reader Service Card

3 in 1 GUARD of the AIR LINE

M·B

WHIRL-A-WAY
FILTER-REGULATOR
and
LUBRICATOR ASSEMBLY
MODEL W-3

the BEST PROTECTION TO YOUR AIR-VALVES, CYLINDERS, PNEUMATIC TOOLS, ETC.



The FILTER removes solids .00039 and larger. TRANSPARENT BOWL provides visibility. REGULATOR capable of passing large volume with unrestricted flow and minimum pressure drop. LUBRICATOR delivers desired volume of oil. Bowl can be refilled without shutting off air supply.

ANY OF THESE 3 DEVICES CAN BE USED AS SEPARATE UNITS OR IN ANY COMBINATION

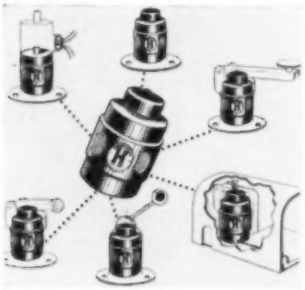
WRITE FOR LITERATURE

M·B PRODUCTS
46 VICTOR AVE., Div. 10
DETROIT 3, MICHIGAN

Circle 91 on Reader Service Card

valve and develops greater thrust from smaller coils.

Construction: Valve has no internal packings, springs, pistons, or sliding metal-to-metal contacts. Ma-



chined from solid bar steel with corrosive resistant finish, valve is equipped with Buna-N rubber diaphragms. Application is for 125 psi, —40 to 225 degrees F.

Humphrey Products
General Gas Light Co.
Kalamazoo, Mich.

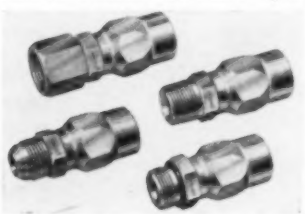
Circle 202 on Reader Service Card

RE-USABLE HOSE FITTING

. . . eliminates hose stripping

Designation: Hoze-lok

Design: Fitting is installed by rotating hose into socket and then screwing the nipple into the hose and socket. The lead thread of the socket, cuts through the rubber cover of the hose permitting the following threads to contact the wire braid. This connection holds beyond



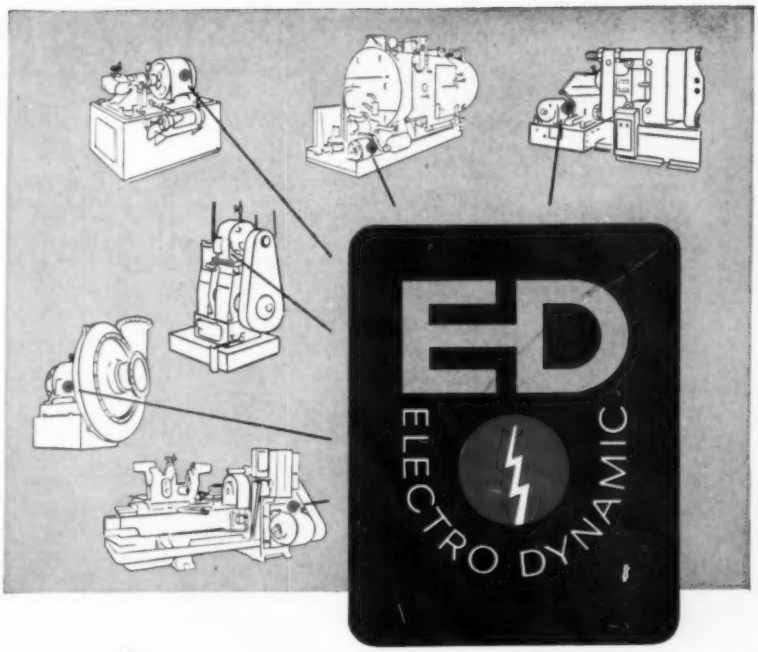
hose bursting pressures and under severe vibration. The rubber of the hose cover is compressed between the threads of the socket. This acts as a vibration damper, adding to the holding power and stress resistance of the hose at the joint where the hose cover has been removed.

Specifications: Fittings are available with four different connecting ends including tapered male pipe thread, straight thread with O-ring sealing, JIC standard 37-degree flare nose for tube connection, and swivel nut for connection with the proper adapter.

Parker Appliance Co.
Cleveland, Ohio

Circle 203 on Reader Service Card

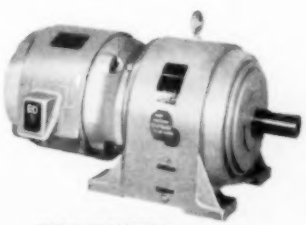
Continued on next page



STANDARD MOTORS

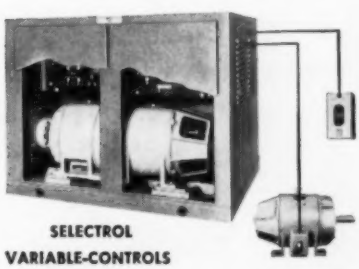
THIS EMBLEM IDENTIFIES EXTRA DEPENDABLE INDUSTRIAL MACHINERY

The red *power spot* on industrial machinery means "Powered by Electro Dynamic." Such machinery relies with confidence on the *extra dependability* of Electro Dynamic motors, the proven industrial motors which give industrial equipment *extra dependable* operation.



GEAR-ED-MOTORS

SELECTRON VARIABLE-CONTROLS



SELECTROL VARIABLE-CONTROLS

NEW...

Write for Brochure 50 and literature on new E.D. motors and drives.

Electro Dynamic division of General Dynamics Corporation Bayonne, New Jersey

ELECTRO *xtra* **DYNAMIC** *ependable motors*

GD

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RUGGED, HEAVY-DUTY
HYDRAULIC CYLINDERS

Attention: O. E. M.
Prompt delivery on any quantity . . . high quality . . . low cost!

Built-in Mechanical Stroke Control

Free catalog and engineering survey, no obligation.

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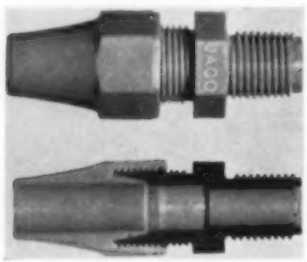
LEWIS ■ PHONE 81 ■ KANSAS

New Products continued

NYLON FITTINGS

. . . for 500 psi

Features: Fittings for use with either metal or plastic tubing are molded from Nylon and have advantages of light weight, low cost



and resistance to attack by acids and alkalis. Galvanic action is prevented and fitting permits joining brass, aluminum, copper and steel.

Specifications: Complete line of shapes and sizes from ⅛ to ½ inch tube and pipe sizes is interchangeable with comparable JIC Standard. Fitting nut has a molded integral ferrule which compresses against the tube or pipe to form a flareless, vibration-proof and leak-proof seal to 500 psi. Temperature range is from −70 to +295 degrees F.

Thomas Associates
Los Angeles, Calif.

Circle 204 on Reader Service Card

AIRCRAFT SELECTOR VALVE

. . . incorporates 7 units

Application: Basically a 4-way, closed center solenoid valve with modifications, the unit is suited for any oil-hydraulic system using an on-off (contactor) type servo-mechanism control. Valve is designed for high pressure, high temperature installations requiring 2-way actuation of controls at two different rates of response, such as the control of a turbo-jet variable exhaust nozzle. Units are for pressures to 4500 psi, ambient air temperatures to 350 degrees F, system

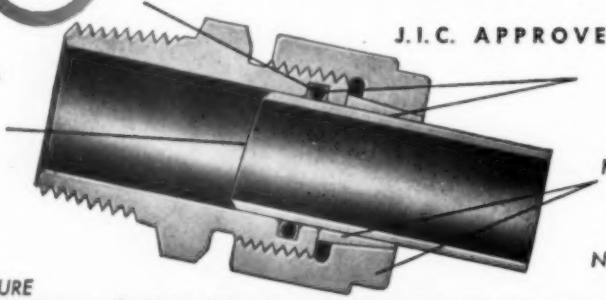
the LENZ "O-RING" TUBE FITTING

J.I.C. APPROVED

NO METAL TO METAL SEAL

NOT NECESSARY TO CUT TUBE SQUARE

NO CONCENTRATION OF STRESSES DUE TO FLARES OR FERRULES FOR TUBE FAILURE



SEAL AND GRIP ARE SEPARATE

HELD BY FRICTION GRIP OF THESE TWO

NO EXACT TUBE LENGTH NECESSARY

See page 2484, Thomas Register (46 edition) for complete list of types and sizes

DO YOU KNOW ABOUT LENZ REDUCER COUPLINGS?

Reducer couplings are adapters for standard bodies, making possible line reductions on any leg by use of standard adapters and adapter nuts.

A HACKSAW AND A FILE IS ALL YOU NEED

Excessive wrench torque is unnecessary for seal does not depend upon tightness of the nut. The higher the pressure the tighter the grip. Solve your hydraulic piping problems the easy way . . . with ease of assembly . . . no matching of exact tube lengths . . . simple leakproof connection for the life of the tube.

Reusable collett holds by friction grip up to bursting pressure of tubing.

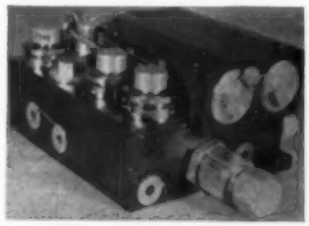
● LENZ FITTINGS MAKE THE JOB AS SIMPLE AS A B C

LENZ COMPANY

Box 1044A • Dayton 1, Ohio • ORegon 9364

fluid temperatures to 300 degrees F, and return fluid temperatures to 400 degrees F.

Design: Package unit houses a restrictor and bypass valve arrangement, pressure relief valve, two



thermal relief valves, pressure switch, solenoid-operated shut-off valve, and check valve resulting in weight and plumbing reduction. Metering principle used provides low pressure drops while controlling over-running loads without cavitation or excessive pressure build-up. The constant gain unit maintains constant flow regardless of load magnitude.

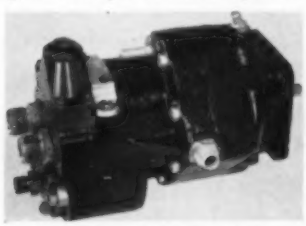
Vickers, Inc.
Detroit, Michigan

Circle 205 on Reader Service Card

VARIABLE DELIVERY PUMP-MOTOR

. . . of swashplate design

Specifications: Pump-motor units are available in three sizes with displacements of .277, 2.5, and 13.5 cu. in. Maximum pressure rating is 2000 psi for the largest and



smallest unit and 3000 psi for the intermediate unit. Horsepower ranges from 8.5 to 135 hp, and speeds are 6000 rpm for the smallest unit, 3000 rpm for the intermediate unit, and 2000 rpm for the largest unit.

Keelavite Rotary
Pumps & Motors Ltd.
Coventry, England

Circle 206 on Reader Service Card

LIMIT SWITCH

. . . has watertight plastic cover

Design: Plastic covers permitting observation of limit switch contacts are made with sturdy acrylic

Continued on page 151

WesCo announces

3 new solenoid designs to make your job easier!

completely tested... proven reliable

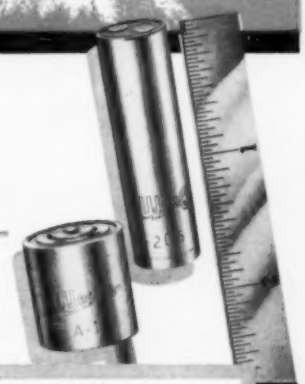
MODEL A-4
(actual size)

PARTIAL SPECIFICATIONS
Temperature to 500° F.
Class H insulation.
Plunger opening sealed to withstand 200 P.S.I.
3 lbs. pull @ 1/16" stroke.
Continuous duty.

2 new miniatures

MODEL A-205 *Shown*
PARTIAL SPECIFICATIONS
PUSH OR PULL
9 oz. @ 1/16" stroke
7 1/2 oz. @ 1/8" stroke
6 oz. @ 3/10" stroke
5 oz. @ 1/4" stroke

MODEL A-1 *Shown*
PARTIAL SPECIFICATIONS
PUSH OR PULL
5 lbs. @ 1/4" stroke
3 1/2 lbs. @ 1/16" stroke
2 1/2 lbs. @ 3/32" stroke
1 1/2 lbs. @ 1/8" stroke



Many other solenoid models available. Mounting furnished to meet your requirements.

The trademark on over 6,000,000 solenoids since 1927

WesCo

NOTICE
WesCo DC solenoids are used throughout the world—are famed for reliable service. The complete line is shown in WesCo's DC catalog. Write for it today—on your company letterhead, please.

Catalogs also available on WesCo's quality AC solenoids. 25 to 400 cycle.

WEST COAST ELECTRICAL MFG. CORP.
233 WEST 116th PLACE • DC DIV. 119 • LOS ANGELES 61, CALIFORNIA • PLeasant 5-1138

Circle 157 on Reader Service Card

Fourth Annual

APPLIED HYDRAULICS

PRIZE PAPER CONTEST

YOU CAN WIN ONE OF THESE PRIZES

FIRST PRIZE . . $500.00

SECOND PRIZE 300.00

THIRD PRIZE . . 200.00

4th to 7th Prizes, each 50.00

Prize papers will be published in Applied Hydraulics. Other papers which are published will be paid for at our regular rates.

If you have a part in the design, fabrication, operation or maintenance of hydraulic or pneumatic components, circuits or systems for industrial or mobile equipment, including aircraft structures, you are eligible to enter the APPLIED HYDRAULICS Prize Paper Contest.

The dynamic growth of the fluid power industry depends on men like you. Already scores of Entry Blanks have been asked for. As one of the judges in last year's Contest put it "this (the Contest) is one of the best possible ways for an ambitious young engineer to get national attention." Decide NOW and send for your Entry Blank. With it will come Rules of the Contest and Suggestions to Contestants. The suggestions, contributed by judges in previous years, will help keep you "on the ball."

Co-authorship is approved, a number of winning papers have been co-authored. Discuss your choice of subject with your department head and begin to make your plans. Judges this year are: F. C. Schuster, Chief Engineer, Industrial Truck Div., Allis-Chalmers Mfg. Co., J. J. Yates, Electric and Hydraulic Engineer, Detroit Diesel Engine Div., General Motors Corp; and H. A. Campbell, Head of General Engineering Labs, Bell Aircraft Corp.

CONTEST CLOSES ON JULY 1, 1956

For Your Entry Blank, address

CONTEST EDITOR

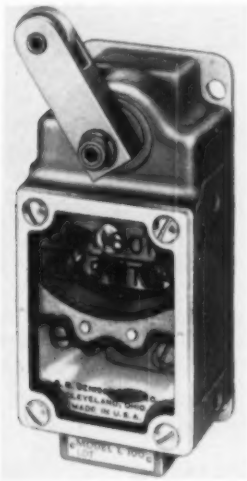
APPLIED HYDRAULICS

812 Huron Road Cleveland 15, Ohio

To get your entry blank Circle 300 on Reader Service Card

New Products continued

plastic material held in position by a steel frame and captive cover screws. Watertight neoprene gasket



provides a positive seal between the housing of the switch and the cover. Seven models and nineteen contact arrangements are available including single-pole, double throw; neutral-position, normally-open; neutral-position, normally-closed; double-pole closed clockwise; double-pole closed counterclockwise, three-pole, two poles closed clockwise, one counterclockwise; and three-pole, two poles closed counterclockwise, one clockwise.

R. B. Denison Mfg. Co.
Cleveland, Ohio

Circle 207 on Reader Service Card

TIMER KIT

. . . for experimental work

Designation: Multi-Cam

Features: Basic construction kit contains motors, switches, cams, gear racks, hardware, tools, and instruction book to assemble 4-cam timers, including a 3-cam, 6-cam, 9-cam, and 12-cam unit. Kit enables engineers to assemble prototype timers for production by the

Continued on page 153

LOW-COST PROTECTION

with Clover Closures

from DUST, DIRT, MOISTURE and THREAD DAMAGE

Threaded caps for AN and SAE external threaded parts — METAL

PLASTIC — Tapered parts for use either as a cap or a plug

METAL — Threaded plugs for AN and SAE internal threaded parts

You can be sure of holding your customers' good will, when you place your product in his hands exactly as you inspected it. Protect your quality during shipment and storage with Clover Closures. There is a size and style in stock to fit all threads and openings. You'll be surprised how little this protection costs.

Write today for samples and prices

IMMEDIATE DELIVERY

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SHUR-FLO

new flow switch automatically protects equipment when fluid flow goes below safe minimum . . .

SHUR-FLO

interlock by HAYS

MESURFLO

new water flow rate control delivers set volume regardless of inlet pressures . . .

MESURFLO

control by HAYS

"Mesurflo" is available as an integral part of an infinite variety of electrically operated valves. The "Shur-Flo" interlock may be combined with other Hays control devices. Six technical folders (including diagrams) are available. What's your flow control problem?

HAYS Industrial Sales Division

HAYS MFG. CO.

804 West 12th Street
ERIE, PENNSYLVANIA

Specialists in electrically operated valves, flow controls, and protective devices.

Circle 64 on Reader Service Card

ELECTRO SNAP ONE-WAY IMPULSE SWITCH

with exclusive advantages for automation

$10.50 plus $.25 shipping charge

Model ES4-KM2
½ actual size

ELIMINATES INTERLOCKING SWITCHES AND COMPLICATED ACTUATING DOGS

Ideal for pulsing solenoid valves on air-hydraulic controls, sequencing circuits, etc., because it allows other controls to reverse or operate the same circuit. Switch sends a short electrical impulse and then switches itself out of the circuit.

GIVES MORE DEPENDABLE CONTROL

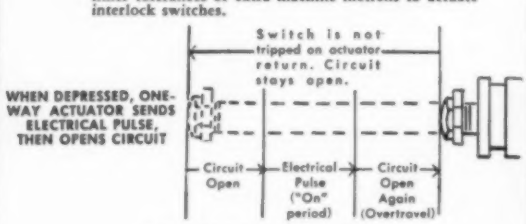
Switch replaces timers, relays, and troublesome one-way dogs to simplify circuits — cuts chances for failure. No delicate adjustments.

LOWERS COST OF CONTROL CIRCUITS

Impulse switch costs less than complicated control devices it replaces. Fewer switches are required for sequencing. Simple mounting.

SPEEDS UP AUTOMATIC OPERATION

Automatic machines can run faster because cycles can be more closely sequenced. There's no delay due to timer tolerances or extra machine motions to actuate interlock switches.


WHEN DEPRESSED, ONE-WAY ACTUATOR SENDS ELECTRICAL PULSE, THEN OPENS CIRCUIT
Switch is not tripped on actuator return. Circuit stays open.
Circuit Open
Electrical Pulse ("On" period)
Circuit Open Again (Overtravel)

SPECIFICATIONS

UL rated at 10 amps/125v AC Movement Dif. 0.020"
Operating Force 3½ lbs.

Model No.	Overtravel	"On" Period (inches of actuator travel)
ES4-KM1	3/8"	1/16"
ES4-KM2	5/16"	1/8"
ES4-KM3	1/4"	3/16"
ES4-KM6	1/16"	3/8"

TRY ON YOUR CONTROL JOB — ORDER NOW

Send Your Standard Purchase Order
Specify Model Wanted—Discounts on Quantity Purchases

ELECTRO-SNAP SWITCH & MFG. COMPANY
4224 West Lake Street, Chicago 24, Illinois

Circle 100 on Reader Service Card

FOR CLEAN, DRY AIR

Distributing Line Of Cool Air From Receiver Tank
Vapor Free Air Near Point Of Use
Take Off From Top Of Pipe
Replaceable Desiccant

MURPHY TRIUMPH AA SEPARATOR-FILTER
Sizes: ¼, ⅜, ½, ¾; Weight 30 lbs; Pressures: 0 to 125 psi; Price: $71.00 ea; Desiccant refills $1.00 ea.

After precooling and separating compressed air, this small unit, placed close to the point of use will finish the job of removing last traces of impurities.

Where very particular work demands dry air completely free from any trace of oil or vapors Murphy Triumph AA is the answer.

AFTERCOOLERS FOR 10 CFM TO 10,000 CFM—SEPARATORS—TRAPS

JAS. A. MURPHY & CO. INC.
Hamilton, Ohio

Manual Quick Disconnect (Push-Pull Positive Action)
Automatic Quick Disconnect (Breaks Away at Pre-determined Weight Load)

WIGGINS
INST-O-MATIC
COUPLINGS

QUICK-DISCONNECT 3000 psi

for Low or High Pressure
HYDRAULIC FUEL and **PNEUMATIC** systems

SIZES: ¼" TO 2½"

write for further information

Wiggins
E. B. WIGGINS OIL TOOL COMPANY, INC.
3424 East Olympic Boulevard
Los Angeles 23, California

Circle 47 on Reader Service Card

Circle 158 on Reader Service Card

kit supplier. This eliminates intermediate steps in the development of special timers.

Application: In a typical application of the timer, a mechanical linkage is made between a motorized

operation, such as a motorized valve control, and a timing unit that is built without a motor. This combination then serves as an accurate device for position indication, or for simultaneous, remote control of related circuits.

Industrial Timer Corp.
Newark, N. J.

Circle 208 on Reader Service Card

AIRCRAFT PRESSURE SWITCH

. . . for 400 degrees F.

Designation: Model 400

Features: Designed for hydraulic, pneumatic, oil, and fuel applications, the pressure switch contains either an aluminum or a stainless steel actuator (sensing element) with present temperature range to

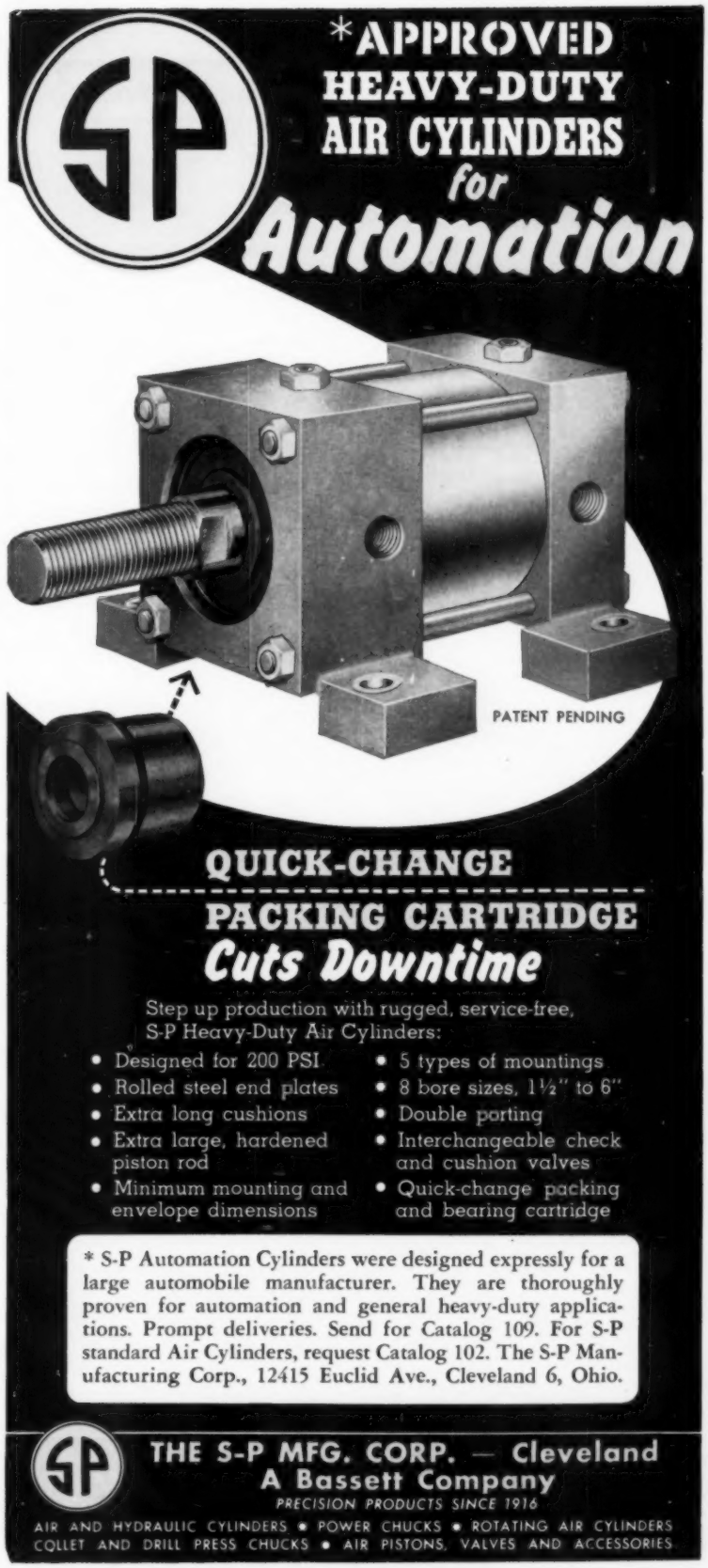
400 degrees F and projected design to 600 degrees F. No seals, springs, or linkages are employed. One moving part works directly on a snap-action switching element.

Specifications: Designed for jet engine use, the switch is available in models for 800 psi with a weight of .36 lb or for 5000 psi with a weight of .65 lb. Length of the switch body is 3½ inches and diameter is 1½ inches. Pressure ports and electrical fittings are standard.

Meletron Corp.
Los Angeles, Calif.

Circle 209 on Reader Service Card

Continued on next page


*APPROVED
HEAVY-DUTY
AIR CYLINDERS
for
Automation
PATENT PENDING
QUICK-CHANGE
PACKING CARTRIDGE
Cuts Downtime
Step up production with rugged, service-free, S-P Heavy-Duty Air Cylinders:
• Designed for 200 PSI
• Rolled steel end plates
• Extra long cushions
• Extra large, hardened piston rod
• Minimum mounting and envelope dimensions
• 5 types of mountings
• 8 bore sizes, 1½" to 6"
• Double porting
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* S-P Automation Cylinders were designed expressly for a large automobile manufacturer. They are thoroughly proven for automation and general heavy-duty applications. Prompt deliveries. Send for Catalog 109. For S-P standard Air Cylinders, request Catalog 102. The S-P Manufacturing Corp., 12415 Euclid Ave., Cleveland 6, Ohio.
THE S-P MFG. CORP. — Cleveland
A Bassett Company
PRECISION PRODUCTS SINCE 1916
AIR AND HYDRAULIC CYLINDERS • POWER CHUCKS • ROTATING AIR CYLINDERS
COLLET AND DRILL PRESS CHUCKS • AIR PISTONS, VALVES AND ACCESSORIES

Circle 130 on Reader Service Card

New Products continued

PRESS SAFETY CONTROL

. . . operates on stored energy

Designation: SCI-200-1

Operation: When pushbutton switches are depressed, line voltage is disconnected from the control, and energy stored in a capacitor is released to operate a solenoid air valve. The pushbuttons must be released to permit recharging the capacitor for the next machine cycle. The control cannot be cheated by tying down one button and operating with the other or by short circuiting. The unit also incorporates a time delay adjustment that permits changing the time interval between the depression of the first and second hand buttons. This feature provides a simple means for training a new operator in efficient production. In addition to non-repeat operation, the systems can be

changed by a selector switch to repeat operation, the system can be foot switch control. With this method the press continues to cycle as long as the hand button or foot switches are held down.

Security Controls, Inc.
Buffalo, New York

Circle 210 on Reader Service Card

ROLLER BEARINGS

. . . with greater load capacity

Designation: Series S. D. M

Features: Radial, thrust, or combined loads are easily accommodated by angular positioning of rollers on spherical raceways. Spherical bearing surface assures full roller contact even with bearing misalignment. Free rolling action is assured

because load is distributed over entire roller. Destructive edge loading cannot occur.

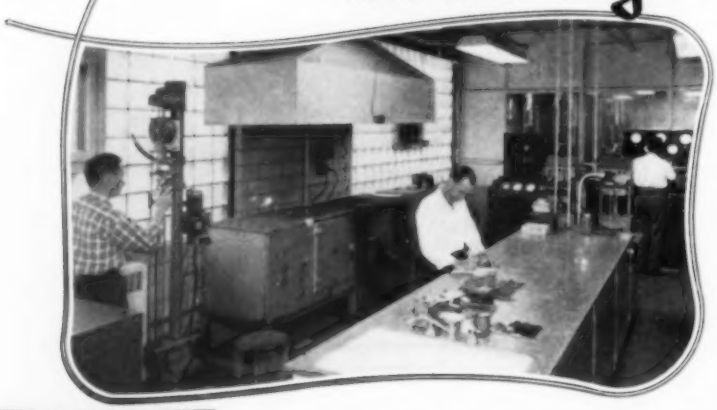
Design: Series S consists of a two-part assembly: one inner ring and roller assembly with a separate outer ring. Series D consists of a three-part assembly: one inner ring and double roller assembly with two separate outer rings. Series M consists of a four-part assembly: one inner ring and double roller assembly with two separate outer rings accurately positioned by a spacer. Self-aligning design provides for a

Continued on page 156

Here's What

DEVELOPED BY GOSHEN RUBBER

means to you...



These Achievements are Goshen Rubber Exclusives

GORSYN
Synthetic rubbers (not silicones) that remain flexible in temperature ranges of —65°F to +300°F; and —20°F to +400°F.

GORLUBE
Low-friction treatment, for O-rings and parts made of natural, synthetic, and silicone rubbers.

GORBOND
Process for securely bonding rubber parts to metals of most every kind.

TETRASEAL
A precision-cut, rectangular-section static seal. Interchangeable with standard O-rings.

When you specify O-rings, or custom-fabricated rubber products "developed by Goshen", the finest laboratory facilities and technical know-how provide the exact compound and the precision fabrication your individual problem demands. Listed here are only a few of Goshen's outstanding achievements in rubber. They may suggest how we can help on your next rubber parts problem. Consultation in design stage is always welcome.

SEND FOR FREE BROCHURE

This 8-page brochure and handy file folder tells how Goshen Rubber can help you. Send for your free copy today.

Our 40th year 1916 · 1956

See our "Facilities" catalog in Sweet's Product Design File.

Goshen Rubber Co. INC.
CUSTOM DEVELOPMENT AND FABRICATION SINCE 1916

1356 S. TENTH ST. GOSHEN, IND.

Circle 58 on Reader Service Card

(*Advertisement*)

Vickers Servo Pump Systems

Provide rapid and accurate response to minute electrical or mechanical signals

The Vickers Servo Pump Unit shown at the right is a signal-controlled, variable delivery, positive displacement, reversible flow oil hydraulic pump. In combination with a rotary or linear hydraulic motor, it forms a signal-controlled hydraulic transmission for remote control operations and high-response servo systems.

The servo transmission may be considered as a power amplifier when viewed from the electrical signal input, of about five watts, to the mechanical power output of several thousand watts. Various sizes of transmissions have been built, having output capacity ratings from one to four hundred horsepower. The servo pump develops only that pressure required to move the load . . . which means reduced pressure over the greater part of the system life since peak loads occur only infrequently in the majority of systems. This greatly reduces power losses and minimizes heat rejection.

Any type of prime mover of sufficient capacity can be used to furnish the power input . . . electric motor, auxiliary drive pad on an airplane engine, air turbine, hydraulic motor, etc. Substantially constant speed is desirable.

Variable Pump Volume Controlled by Signal

Heart of the servo pump unit is the Vickers Variable Stroke Hydraulic Pump. This is usually a nine-cylinder pump housed in a pintle-mounted yoke. Varying the yoke angle varies piston stroke, hence, output volume from zero to maximum in either direction of flow. A stroking piston actuated by a pilot valve varies the yoke angle according to signal.

Low Control Power Requirement

Power for control purposes is low in a servo pump unit because metering valve action is confined to the volume-regulating system which is a low power level (100 to 300 psi) hydraulic system separate from the power transmission hydraulic circuit although a part of the pump unit. This volume-regulating system controls piston displacement and direction in the power pump which can operate at pressures up to 3000 or 4000 psi. Pressure drop across ports of a metering valve, with its inherent losses, is avoided in the power transmission system. Final power output from the pump is determined by the volume of flow which the volume-regulating system demands and by the actual resistance of the load . . . is not dependent upon pressure drop methods of control.

In a control system employing this servo pump, the variations in gain resulting from load change are negligible compared to those which may occur in a similar circuit controlled by a valve metering directly in the power line.

Constant Displacement Hydraulic Motor

Flow and pressure generated in the hydraulic pump are carried by tubing with no intermediate valving to the hydraulic motor or linear actuator. The fixed stroke hydraulic motor provides torque directly proportional to pressure and speed directly proportional to flow rate.

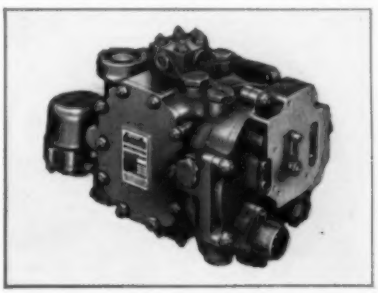
High Power-to-Weight Ratio

The servo pump unit and its associated hydraulic motor are designed for high power-to-weight ratio, high torque-to-inertia ratio, low inertia of rotating parts, and high resonant frequency.

Typical Example

High power-to-weight ratio—3.76 hp/lb (motor only)
High torque²-to-inertia ratio—3.5 x 10^7 lb-in./sec²
Low inertia of rotating parts— .052 lb-in.²
High resonant frequency— 20 cps (entire system)

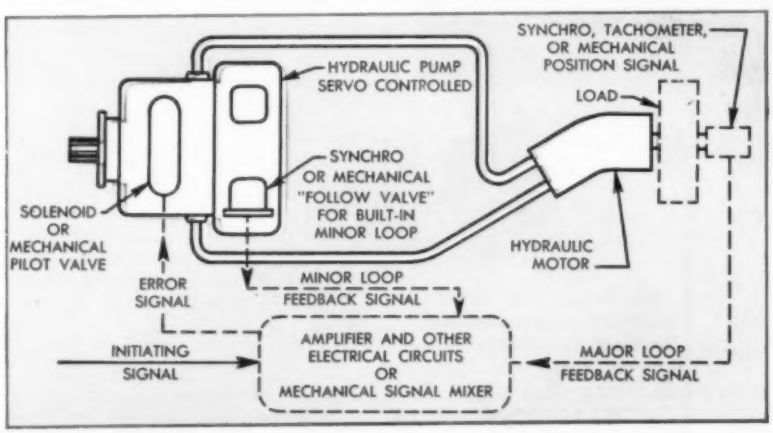
Other advantages are reliability and versatility of application. The smooth,



stepless speed changes and ability to hold position against any variation in load are additional reasons why this unit is a desirable resource which can solve many design problems.

Important among the applications of Vickers Servo Pump Units is extremely fast and accurate positioning of gun turrets on aircraft. Another is actuation of the exhaust nozzle for jet engines; here the servo pump's characteristic of providing at all times only sufficient power to meet the momentary demand minimizes the power loss and therefore the heat rejection. The greatly reduced average pressure level in this type of system prolongs the life and improves the reliability of all components.

For further information, ask for Bulletins SE-15 and SE-18 or get in touch with your nearest Vickers Aircraft Application Engineer. He can arrange for an engineering team to consider your problem and propose an optimum solution.


SYNCHRO, TACHOMETER, OR MECHANICAL POSITION SIGNAL
HYDRAULIC PUMP SERVO CONTROLLED
LOAD
SYNCHRO OR MECHANICAL "FOLLOW VALVE" FOR BUILT-IN MINOR LOOP
SOLENOID OR MECHANICAL PILOT VALVE
HYDRAULIC MOTOR
ERROR SIGNAL
MINOR LOOP FEEDBACK SIGNAL
INITIATING SIGNAL
AMPLIFIER AND OTHER ELECTRICAL CIRCUITS OR MECHANICAL SIGNAL MIXER
MAJOR LOOP FEEDBACK SIGNAL

SIMPLIFIED DIAGRAM illustrates a servo control system employing Vickers Servo Pump Unit and Constant Displacement Hydraulic Motor. This system accepts initiating signals (either electronic or mechanical, depending on type of system), compares them with feedback signals from load and (through controlled changes in direction and volume of fluid pumped to motor) corrects the load as required. For added accuracy and stability, a minor loop providing signals proportional to rate of flow may be added. This may either be built into the pump in the form of a mechanical "follow valve" which results in modulating the flow as a function of the net signal to the pump, or may be a synchro which feeds a signal proportional to flow rate into the amplifier. The controlled output may be either a function of the position or velocity of the load.

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
ADMINISTRATIVE and ENGINEERING CENTER
Department 1474 • Detroit 32, Michigan

Aircraft Application Engineering and Service Offices: El Segundo, California, 2160 E. Imperial Highway • Detroit 32, Michigan, 1400 Oakman Blvd. (Service Only) • Arlington, Texas, P. O. Box 213 • Washington 5, D.C., 624-7 Wyatt Bldg. Additional Service facilities at: Miami Springs, Florida, 641 De Soto Drive

TELEGRAMS: Vickers WUX Detroit • TELETYPE "ROY" 1149
CABLE: Videt

OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd. Great West Road, Brentford, Middx., England

Engineers and Builders of Oil Hydraulic Equipment Since 1921

New Products continued

total variation in alignment of 3/8 inch within a radius of 12 inches or 3 1/8 inch within a radius of 5 feet.

Link-Belt Co.
Chicago, Ill.

Circle 211 on Reader Service Card

EXPLOSION PROOF MOTORS . . . 1 to 30 hp

Designation: Type H

Features: Rerated NEMA motors are for Class I Group D service for areas where inflammable gasses and volatile liquids are present, and for Class II Groups F and G service for areas where combustible dusts are present. Frame 182 and 184 are non-ventilated. Frames 213 through 326U are equipped with sparkproof aluminum fan, cast iron conduit box, long register, one piece cast iron frame, and end bracket with eight bolts on each end bracket.

Electro Dynamic Div.
General Dynamics Corp.
Bayonne, N. J.

Circle 212 on Reader Service Card

STEEL NEEDLE VALVE . . . with O-ring or packing

Design: Bar-stock valves are available in straight or angle patterns in sizes from 1/8 to 1/2 inch. O-ring style is applicable to test panel, high pressure air or hydraulic service and can be processed for vacuum uses. No packing adjustments are required in valves with O-ring seals,

and a back-seating feature permits repacking under pressure. A self-aligning spindle ensures tight seating.

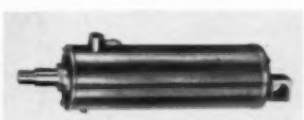
Application: Valves with carbon steel bonnets and stainless steel bodies are for high temperature applications to 750 degrees F. Other bar stock materials include brass and 430F stainless steel. All valves can be ordered for direct instrument panel mounting with black plastic handwheels.

Hoke, Inc.
Englewood, N. J.

Circle 213 on Reader Service Card

OIL CYLINDERS . . . of heavy-wall tubing

Construction: Cylinders in 5, 6, 7, 8-inch bore sizes are bored and honed to mirror finish. Designed for 1000 to 1500 psi cylinders have heavy-duty cast iron pistons and rings with V-type packing. Single or double acting cylinders are avail-



able with threaded, plain, or pin-eye rod fittings and cylinder mountings.

Wisconsin Hydraulics, Inc.
Milwaukee, Wisconsin

Circle 214 on Reader Service Card

ALWAYS...MAINTAIN CONSTANT, UNIFORM HYDRAULIC PRESSURE
NO NOISE . . . NO MAINTENANCE

America's most dependable valves . . . select from 5 springs for desired pressure from 0# to 500# . . . and INSTALL, NO FURTHER ATTENTION NEEDED . . . EVER.

Standard and Flange models
Pipe sizes: 1/4" to 2"; brass or cast iron bodies.

PROVED MOST SUCCESSFUL AND ECONOMICAL for machine tool hydraulic mechanisms, oil-burning equipment, rams, presses and Diesel engines.

WRITE—on your letterhead—for your personal copy of

FULFLO MECHANICAL DATA BOOK

Specify if for Valves, for Pumps or for both.

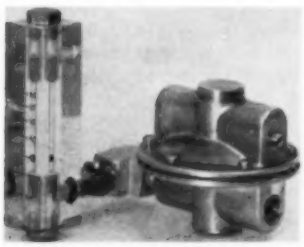
FULFLO
THE FULFLO SPECIALTIES CO. Inc.
PUMP AND VALVE MANUFACTURERS
BLANCHESTER, OHIO

DIFFERENTIAL PRESSURE REGULATOR

. . . with integral needle valve

Designation: Model H-21F

Application: Unit can be used for economical purging with air, water, or gas in services where ac-



tual measurement of the flow is unnecessary. It can also be supplied in combination with a small flow-rate indicator as a complete, compact, inexpensive purge meter package. Ranges from .2 to 2 scfh of air and 20 to 200 cc per min water are available. Cost is about one-half that of standard purge assemblies now on market.

Coneflow Corp.
Philadelphia, Pa.

Circle 215 on Reader Service Card

PUSH-ON HOSE FITTING

. . . for simple maintenance

Features: Brass fitting is available in ¼, ⅜, and ½-inch sizes and is designed for use with rubber covered hose for pressures to 250

psi. The fitting is assembled dry or with water as a lubricant by pushing the hose over twin ferrules on the fitting stem. The unit permits hose replacements without removing the fitting from a machine.

Specifications: Fitting is available in six types including rigid male pipe, swivel female SAE 45-degree flare, swivel female SAE 37-degree flare; swivel male inverted nut, rigid male SAE 45-degree flare, and rigid female inverted fittings.

Flex-O-Tube Div.
Meridan Corp.
Inkster, Michigan

Circle 216 on Reader Service Card

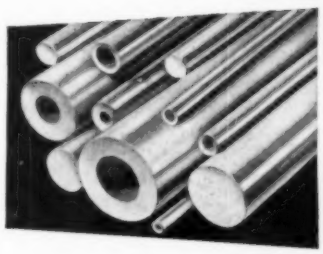
TEFLON*

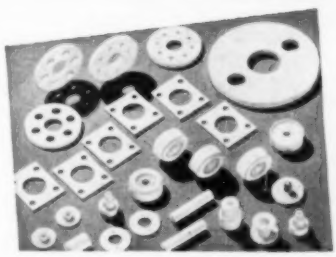
SHEET....ROD....

TUBING....MOLDED OR MACHINED PARTS?

YOU CAN GET JUST WHAT YOU WANT

from JOHN CRANE





"Made of Teflon by JOHN CRANE" has become practically a standard specification for parts and components subject to severe electrical, corrosive, thermal, mechanical or atmospheric abuse. Whatever your requirements in Teflon . . . sheet, rod, tubing, packings, gaskets, bellows, insulators, sealing discs or non-stick parts . . . "John Crane" can supply them!

In addition, you get these important *plus* factors: complete uniformity throughout, high density control, freedom from flaws and rigid adherence to your specifications.

"John Crane's" complete fabrication facilities assure you prompt delivery on *exactly* what you want —no compromise. If you have an entirely new requirement, no standard design or procedure— "John Crane's" laboratory facilities, know how, research and engineering experience go to work on *your particular* need.

Now is a good time to put "John Crane" to test. Contact Crane Packing Company today.

*TEFLON *DuPont trademark*

Advantages:

CHEMICAL—Completely inert

ELECTRICAL—Extremely low power factor
Very high dielectric strength

THERMAL—Temperature range
—300°F. to +500°F.

MECHANICAL—Strong, flexible
Weather resistant

LOWEST COEFFICIENT OF FRICTION

ABSOLUTELY NON-STICK

Crane Packing Co.
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JOHN CRANE **CRANE PACKING COMPANY**

OFFICES IN ALL PRINCIPAL CITIES

MAGNETIC PORO-KLEAN FILTER element. In use, submicronic ferromagnetic particles stick like clips in photo.

Magnetic filter protects servo valves

A sticky servo valve in the hydraulic control system for a Mach one-plus airframe is sticky business indeed!

Yet Cuno engineers recently encountered just such a problem. Submicronic wear particles, well below the size range of conventional filters at the temperatures and pressures involved, contaminated the hydraulic fluid. These tiny particles, in the servo valve caused erratic operation, and instability.

Magnetic PORO-KLEAN is answer

FILTRATION NEWS

Cuno's new magnetized porous iron filter solves this problem by removing ferritic wear particles 2 microns and smaller as well as all larger non-magnetic particles. Three models have been designed to handle ½, 3 and 8 gpm of MIL-0-5606 hydraulic oil.

Filters to AN specs or better

Standard PORO-KLEAN filters of porous 316 stainless steel are also available in a complete range of standard AN 6235 sizes for operation to 350°F. Similar filters for use to 900°F. and a variety of cup, cylinder and disc shapes are also available.

Ask your local Cuno representative for all the facts on versatile, high-strength, high-temperature, corrosion-resistant PORO-KLEAN for aircraft or industrial filters. Or write Cuno Engineering Corporation, 2-5 South Vine Street, Meriden, Conn. 5.21

FREE! Send for new PORO-KLEAN Catalog No. 058!

CUNO ENGINEERED FILTRATION

AUTO-KLEAN (edge-type) • MICRO-KLEAN (fibre cartridge)
FLO-KLEAN (wire-wound) • PORO-KLEAN (porous stainless steel)

Useful Literature continued

HOSE COUPLING . . . of a 4-bolt, split-flange design is discussed in Catalog No. 400 from Anchor Coupling Co., Inc. The coupling uses an O-ring seal, and does not require thread compounds. Spiral leaks and wedging of pump or valve bodies by tapered pipe threads are eliminated, and use of thinner sections on valve and pump bosses is possible. Short, stiff assemblies may be conveniently used because no deflection or twisting of hose is required in making a joint—only an automotive type wrench is required for installing.

Circle 237 on Reader Service Card

ELECTRONIC TIMER . . . for timing applications of short time duration where a device with long life, low maintenance, and high repetitive accuracy is required is described in GEA 5255B issued by General Electric Co. Three time ranges are available for .06 to 1.2 seconds, .6 to 12 seconds, and 6 to 120 seconds. The unit can be used to control time duration of an operation, provide an alarm or actuate a protective device, or to sequence successive operations. Contacts are rated for 10 amperes continuous current and are good for at least a million operations. Photographs indicate construction and mounting features and a dimensional drawing is included.

Circle 238 on Reader Service Card

GASKETS . . . and molded rubber parts, products of The Aero Gasket Corp. are outlined in a new brochure. Facilities of the company and typical designs are illustrated showing molded rubber parts, diaphragms, non-metallic gaskets, rubber-to-metal bonded assemblies, metallic gaskets, and laminated gasket assemblies .Diaphragms are fabricated from synthetic or natural rubber on such fabrics as cotton, Nylon, Dacron, Orlon, and Teflon. Metal supporting rings can be bonded to diaphragms for more rigid support.

Circle 239 on Reader Service Card

V BELT DRIVES . . . is the subject of a 36-page manual covering their history, standards, and design. The booklet tells how to engineer a V-belt drive and gives examples with data tables. Modifications in V-belt drives is the title of one section of the manual dealing with V-flat drives, quarter turn drives, double V or hexagon belts, and others. A section of questions and answers gives much valuable practical information on this engineering subject. The booklet is designated as 20E8297 an dis offered by Allis Chalmers Manufacturing Co.

Circle 240 on Reader Service Card

AIR VALVES . . . products of Airmatic Valve, Inc. are the subject of a condensed catalog issued by the company. Seventeen types are illustrated and briefly described. These include 2, 3, and 4-way types for flow control, sequence control; and pilot, solenoid, cam, or manual operation. Also included in the catalog are pressure regulators and strainers for air and oil. Cylinders with 1⅛ and 1½-inch bores for pressures to 1500 psi are presented. The valves are for pipe sizes of ¼, ⅜, ½, and ¾ inch.

Circle 241 on Reader Service Card

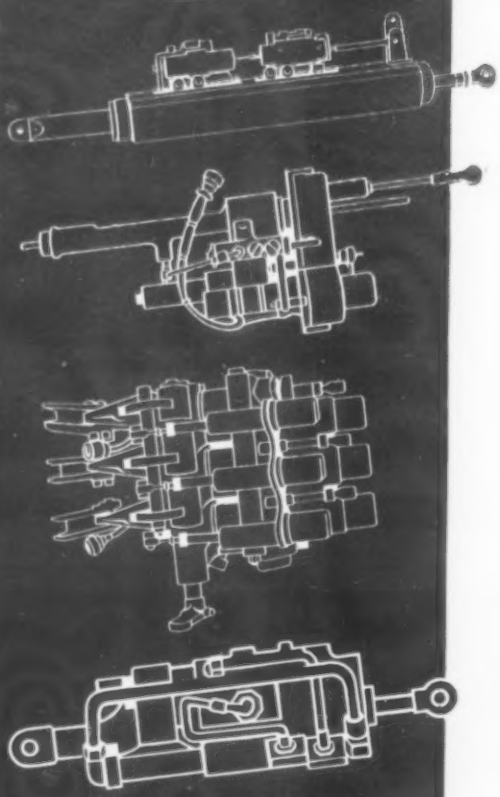
COMPACT HYDRAULIC UNIT . . . including electric motor, pump and coupling, integral reservoir, valving for cylinder actuation, and optional pressure switch is presented in a brochure from Oil-Dyne, Inc. The package unit operates at 3000 psi with peak pressures to 5000 psi. The motor range is 1/100 to ½ hp and the unit eliminates separate solenoid valves and other components. The brochure includes a chart showing delivery vs. pressure for five units, and gives sectional drawings of the pressure switch and cylinders. Dimensional drawings are presented and wiring diagrams for various arrangements are included. Cylinders of ½, ¾, 1, and 1¼-inch bores are completely specified.

Circle 242 on Reader Service Card

TUBING . . . and fittings are described in three bulletins recently issued by The Babcock & Wilcox Co. Bulletin TB-408 specifies seamless and welded tubing of stainless, alloy, and carbon steels. Chemical

Continued on page 161

Electrol Makes all types of HYDRAULIC PRODUCTS



HYDRAULIC ACTUATORS—available in single acting, double acting and tandem types.

INTEGRATED POWER CYLINDERS—designed to specification, complete with integral valving in both hydraulic and electrical control types.

Free — Hydraulic Technical Journal for Design Engineers

For instance . . .

HYDRAULIC ACTUATORS and POWER CYLINDERS

Electrol's newer developments of precision hydraulic actuators and integrated power cylinders are today fulfilling the more exacting requirements for both aircraft and industrial applications.

In aircraft, Electrol units are being used for advanced hydraulic circuits to position flight controls—manually or by automatic pilot. *In industry,* Electrol hydraulics provide the ideal means of controlling tools where a high degree of accuracy is required.

Investigate the many engineering, production and cost-saving advantages by having Electrol work with you on your fluid power requirements. Our engineering and development staffs are ready to assist in applying advanced hydraulics to your specific design.

Bulletin No. 101 — Bulletin No. 102 — Bulletin No. 103

Send for our latest bulletins covering hydraulic valves, powerpaks, hand pumps and landing gear.

Write today requesting we add your name to the mailing list of "THE HYDRAULIC ENGINEER" — a publication designed to keep you posted on hydraulic developments.

Electrol INCORPORATED
HYDRAULICS
KINGSTON, NEW-YORK

CYLINDERS • SELECTOR VALVES • FOLLOW-UP VALVES
CHECK VALVES • RELIEF VALVES • HAND PUMPS
POWERPAKS • LANDING GEAR OLEOS • SOLENOID VALVES • ON-OFF VALVES • SERVO CYLINDERS • TRANSFER VALVES • CUT-OUT VALVES • SPEED CONTROL VALVES

Better Designed Products Use Electrol Hydraulics

Member National Fluid Power Association

Circle 22 on Reader Service Card

YOUNG HEAT EXCHANGERS

for plastics molding presses . . . . . dissipate hydraulic heat

Rear view of an HPM 100-ton plastics transfer molding press.

Eliminates Carbon Deposits in Pumps and Maintains Viscosity of Hydraulic Oils . . .

To insure proper dissipation of hydraulic heat, the above plastics press was equipped with low cost Young Type "F" Heat Exchangers. Heat is built up as liquid plastic at 300 to 500° F. is forced into the mold chamber. Under this action Young Coolers maintain a maximum operating temperature of 115° F. in the hydraulic fluid. This heat removal is accomplished with minimum pressure drop using a minimum of water. Young Heat Exchangers also prevent the possibility of carbon formation in pumps. Available in fixed or removable tube bundle models for either fresh or salt water service.

Write Dept. 446-E for FREE Catalog

Put *Young Talent* to work for you . . .

Solving heat transfer problems is what we do best because it is our very reason for being. You, too, can harness the power of Young engineering talent. Write, wire or call without obligation.

Young RADIATOR COMPANY

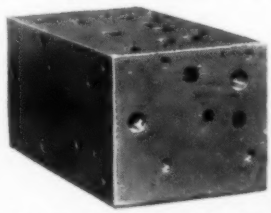
RACINE, WISCONSIN

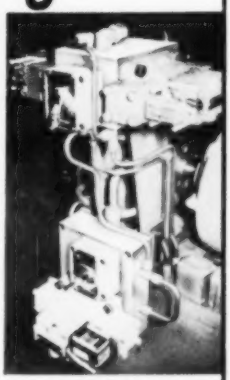
Creative HEAT TRANSFER ENGINEERS FOR INDUSTRY

Heat Transfer Products for Automotive, Aviation and Industrial Applications. Heating, Cooling, Air Conditioning Products for Home and Industry.

Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois

Your manifold problems *Solved*





We are Drilled Manifold Specialists! We can manufacture to your specifications . . . or design special manifolds to fit your needs.

Will accommodate from ⅛" to 1½" valves.

Drilled manifolds of solid ground steel offer such advantages as:

- LOWER COST
- COMPLETELY LEAK-FREE
- MORE COMPACT
- BETTER APPEARANCE
- EASY VALVE SERVICING

Send for FREE Booklet

Birmingham Hydraulic

DRILLED MANIFOLDS 14253 W. 11 Mile Rd.—Oak Park, Mich.

A LOW COST SOLUTION TO ALL AUTOMATIC DESIGN PROBLEMS

CARTER *Power-Pack*

AIR CYLINDER AND VALVE

- Only One Air Connection
- Built-in Cartridge Valves
- Integral Speed Controls
- Solenoid or Air Limit Control

The cylinder-valve combination that is *complete!* A rugged, dependable cylinder... with sensitive, accurate, versatile valving built right in! Ideal for designing into auto-control setups! Close coupled or remote, positive, easy maintenance. Check into Power-Pack today!

Carter Controls, Inc.
2972 Bernice Road
Lansing, Ill. • GRanite 4-3305

EVERY DESIGNER SHOULD HAVE A COPY OF THIS NEW BULLETIN

Circle 160 on Reader Service Card

Circle 28 on Reader Service Card

analyses, physical properties, and creep strength for various materials are included. Folder FB-500 shows various types of welding fittings in alloy, stainless, and carbon grades. Complete specifications are given for the fittings which feature precision-cut bevel ends, uniform wall thickness, smooth inner surface, full radius turns, and controlled grain structure. Bulletin TB-360 outlines mechanical tubing available from the company.

Information on the selection of proper tubing is given and technical literature on application and selection is listed.

Circle 243 on Reader Service Card

AIRCRAFT VALVE . . . A 3-way, 3000-psi solenoid valve which handles 85% higher flow than conventional units is presented in a catalog sheet from Aircraft Products Co. This series 6000 valve permits flows of 6 gpm through either ¼-inch or ⅜-inch tubing. The valve incorporates features which permit flow to be reversed between any two open ports without disturbing the flow or operating characteristics of the valve. The Series 6050 valve for low pressure drops or higher flows is also discussed. Both models are rigidly qualified to exceed MIL-V-5529A. A graph of pressure drop vs. flow indicates performance of the valves.

Circle 244 on Reader Service Card

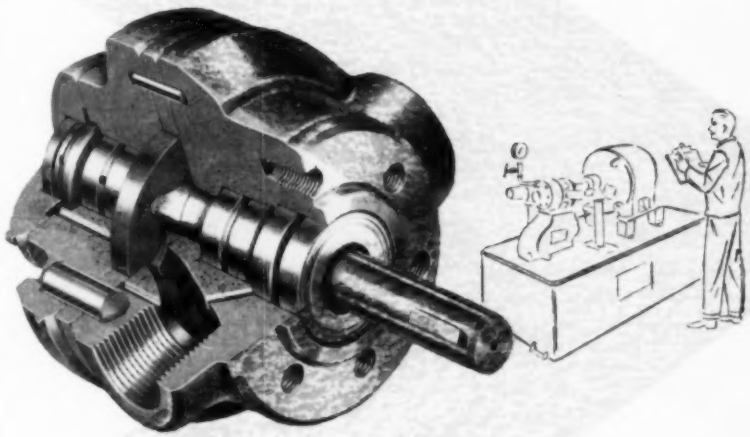
TEST STANDS . . . manufactured by Test Equipment Div. Consolidated Diesel Electric Corp. are illustrated and described in a brochure available from the company. Included is a portable hydraulic test stand for airline and military use with flows to 50 gpm, pressures to 5000 psi, and temperature control. A pneumatic test stand for pressures to 5000 psi with 5 scfm flows is illustrated. Hose and tube testers are available for pressures to 30,000 psi.

Circle 245 on Reader Service Card

LUBRICANT . . . used successfully with pumps, valves, and for impregnation of seals is covered by collected literature available from The Alpha Molykote Corp. The literature includes a paper on the properties and uses of pure molybdenum disulfide as a lubricant, and bulletins explaining types of the

Continued on next page

Gerotor Hydraulic Pumps



give Higher Efficiency at Lower Operating Cost!

All Gerotor hydraulic pumps are recognized throughout industry for their outstanding design and performance. Heart of each unit is the exclusive *Gerotor* mechanism, both elements of which revolve in the same direction at relative low speed. This results in *longer life, less slippage, less wear,* a *smoother,* more *uniform flow.* In your plant or in your product—a GEROTOR pump means *higher efficiency* at *lower operating cost.*

Due to modern production facilities, GEROTOR can produce special pump designs in *quantities* on an economical basis. Whatever your hydraulic pump problems, bring them to GEROTOR.

Free literature available . . . *write:*

GEROTOR

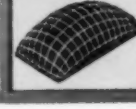
MAY CORPORATION

MANUFACTURERS OF—

1535 MARYLAND AVENUE, BALTIMORE 3, MARYLAND

Hydraulic Pumps and Motors

Variable Speed Hydraulic Transmissions



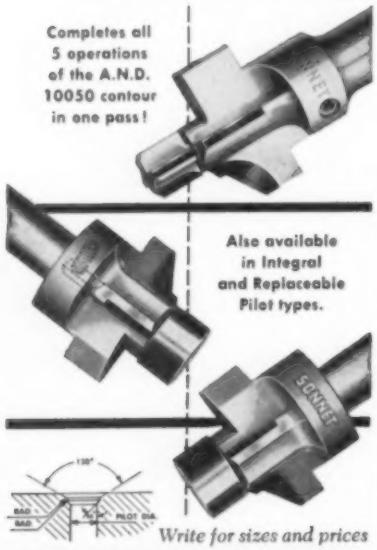
PneuBin—Pneumatic Bin Evacuators

Circle 56 on Reader Service Card

Circle 136 on Reader Service Card

Sonnet A.N.D. 10050 Port Contour Cutter

now available in a NEW Replaceable Reamer Type


Completes all 5 operations of the A.N.D. 10050 contour in one pass!
Also available in Integral and Replaceable Pilot types.
Write for sizes and prices

SONNET TOOL and MFG. CO.
571 No. Prairie Avenue • Hawthorne, California

Useful Literature continued

lubricant for various applications. Prices are given for grease-film lubricant, dry-film lubricant, and dispersions. A leaflet titled "Pioneering in Lubrication" outlines facilities of the company and its product for use where extreme bearing pressures or excessive temperatures make conventional lubricants unsatisfactory. A field report gives excerpts from letters explaining applications in hydraulic equipment. Use of the lubricant as an additive to hydraulic fluids is reported to produce considerable reductions in friction of rubber and leather O-ring packings.

Circle 246 on Reader Service Card

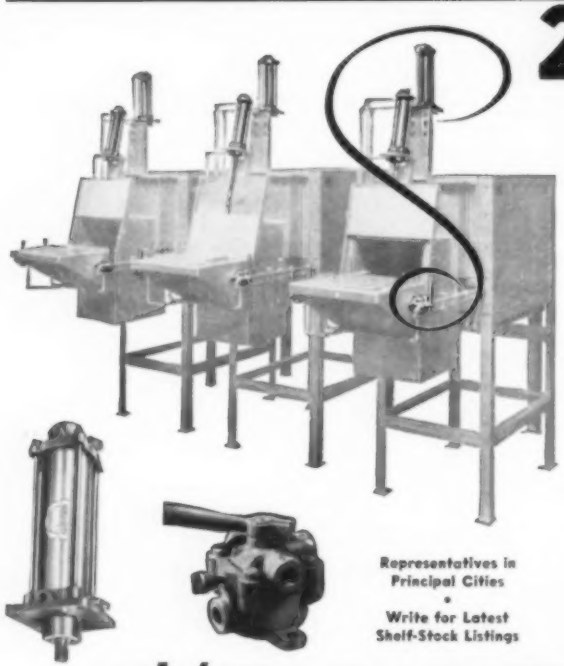
HYDRAULIC HOSE . . . and fittings are discussed in a catalog from Reda-Turner Mfg. Co. The hose ranges in size from ¼ to 1-inch ID and is recommended for pressures ranging from 1000 psi in the larger size to 4500 psi in the smaller size. The hose is reinforced with high tensile wire braid, smooth black oil-resisting synthetic tube, and cover. The catalog also specifies the company's lines of air hose fittings, flare fittings, and pipe fittings, as well as needle valves which are built to customer specifications.

Circle 247 on Reader Service Card

PRESSURE TRANSDUCERS . . . for the measurement of differential pressure are specified in Bulletin No. MPT-134 issued by Statham Laboratories, Inc. These units have a sensitivity of 20 millivolts full scale, open circuit, at 5 volts. The transduction is by a resistive, complete balanced bridge, strain gage. The units have a resolution of less than .01% of full scale and a nonlinearity plus hysteresis of less than ±1% of full scale. The bulletin indicates ranges, and has a chart of linear acceleration response along any axis. Natural frequency, electrical details, dimensions, and other details are given.

Circle 248 on Reader Service Card

20 YEARS Trouble-Free Service on Hevi Duty Electric Furnaces



Hevi Duty Electric Co., Milwaukee, builder of Electric Heat Treating Furnaces, has found that NOPAK Cylinders and Valves can be depended upon for the many years of trouble-free service which users expect of Hevi Duty Furnaces. Not once in 20 years has a Hevi Duty customer returned a NOPAK Component for replacement.

The furnaces pictured are used to harden steel dies employed in the manufacture of jewelry. Outer doors, inner partitions and conveyor trays . . . all are actuated by NOPAK Cylinders controlled by externally mounted NOPAK Valves.

Another reason why Hevi Duty specifies NOPAK Products is the simplicity and ease of their installation . . . an important factor in cutting assembly costs.

Examples showing how NOPAK Products are used in other types of machinery and equipment are described in the NOPAK Application Manual. Ask your NOPAK representative, or write for your copy.

Representatives in Principal Cities
•
Write for Latest Shelf-Stock Listings

NOPAK
® VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

GALLAND-HENNING NOPAK DIVISION
2743 SOUTH 31ST STREET • MILWAUKEE 46, WISCONSIN

A 8633-½-H

SILICONE OIL . . . with unusual viscosity properties and high ignition temperatures is specified in Form 8007 D released by Linde Air Products Co. Div. of Union Carbide & Carbon Corp. The literature explains that because of the unusual viscosity properties and high ignition temperatures of silicone oil, it is of considerable value as a damping fluid for shock absorbers, dashpots, and delicate instruments. Since the viscosity of the oil shows little change with temperature, it is very useful for year-round operation of many special hydraulic systems.

Circle 249 on Reader Service Card

SPECIAL CYLINDERS . . . manufactured by The Oilgear Co. are outlined in Bulletin 79000. Available for 1500 psi, 3500 psi or higher pressures, the heavy-duty cylinders cover a variety of special applications that could not be accomplished with a standard cylinder. Cylinder design incorporates rugged cast alloy iron, nodular iron, cast steel, forged steel or bar steel heads as required by mounting and service. Confined, preloaded O-rings provide leak-free static and pressure seals between body and heads and between pipe flanges and heads. Adjustable hydraulic cushions reduce the metallic impact and shock. Diagrams for various types of porting are included with photographs of special cylinders for strokes to 216 inches and bores to 24 inches.

Circle 250 on Reader Service Card

FLUID TRANSFERS . . . for passing fluid under pressure from a stationary member to a rotating member of a machine are outlined in Bulletin 12 issued by Sealol Corp. Three types of units are specified for pressures of 500 and 1000 psi and for gun drilling with a single edge drill with a coolant hole extending the length of the drill from the shank or driver to the cutting end. This type of drilling gives extremely accurate holes, in some cases equal to a honed hole. A graph shows horsepower at 1000 rpm vs. pressure for the units. Speeds to 10,000 rpm are possible with the fluid transfers.

Circle 251 on Reader Service Card

OIL FILTERS . . . Low-cost depth-type filtration for applications where oil must be kept absolutely clean is available with a new line of bulk refill oil filters described in Bulletin 301 from Houdaille-Her-

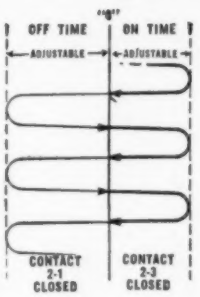
Continued on next page

EAGLE FLEXOPULSE repeat cycle timer

WITH S.P.D.T. SWITCH

No gear change or resetting of cams required

This Flexopulse Repeat Cycle Timer is ideal for controlling processing machines requiring adjustable timed cycles. The "on" or "off" intervals are easily adjusted. Either can be adjusted without disturbing the setting of the other. Instead of resetting cams or changing gears, simply loosen two knurled nuts. Then set "on" and "off" periods by moving adjustable pointer. Tighten screws, and the job's done.



HAS CYCLE PROGRESS INDICATION:

A movable flag indicator passing over the time scale between adjustable arms, indicates portion of cycle elapsed in either of the s.p.d.t. positions. Switching operation takes place at zero.

Flexopulse is ideal for periodically operating valves to reverse the flow of liquids, for operating signals or for injecting chemicals. 120-second up to 20-hour dials are available. Synchronous motor powered. Send coupon today for free Bulletin 320.

FREE BULLETIN, MAIL COUPON

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. AH-556
MOLINE, ILLINOIS

Please send free Bulletin 320 with full data on Flexopulse Repeat Cycle Timer.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

Circle 43 on Reader Service Card

Useful Literature continued

shey of Indiana, Inc. The bulletin presents features of the filters in cutaway drawings and descriptions. Characteristics such as tank diameter, working pressure, gallons of oil required to fill filter, etc. are given in chart form for nine models. An important innovation in these new models is a quick-opening cover that greatly simplifies changing of refills. Covers are fastened by swing bolts which swing down and release the cover. On smaller models the cover can be removed by one man. On larger models, a special cover-lifting device raises and swings the cover to one side.

Circle 252 on Reader Service Card

PERMITS THE USE OF MORE ABRASION-RESISTANT, RUBBER-COVERED HOSE

Insure longer wear in your hydraulic hose assemblies—and at the same time, save assembly time by avoiding old-fashioned skiving. Joy Surgepruf re-usable couplings make *both* advantages possible. Their exclusive "double-wedge" grip lets you use tough, abrasion-resistant, rubber-covered hose instead of the braided type—without any need for skiving the hose at the connection.

NO SPECIAL ASSEMBLY TOOLS REQUIRED

You need no mandrels or other special tools to make up Surgepruf assemblies. No extra expense or special technique is involved.

CAN BE RETIGHTENED WHEN LOOSE ON THE HOSE

Machine vibration or hose flexing can loosen any hydraulic coupling on the hose in time, but Surgepruf Couplings can be easily, quickly retightened on the job to stop a leak—*another* exclusive feature.

Surgepruf Hose Couplings are made to JIC Standards. Assemblies are available in many sizes and lengths, and in both single and double-wire reinforced types for medium-high and high pressure service respectively. *Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*

Get complete data on Surgepruf:
Write for FREE Bulletin 75-19
Consult a Joy Engineer

JOY
HYDRAULIC ASSEMBLIES THAT GIVE YOU MAXIMUM RELIABILITY

WSW H-5506-75

"AIR, WATER AND INDUSTRY" . . . is an interesting 20-page booklet which tells the important story of why there is moisture in air lines, how it got there, and its destructive action. The pocket-size edition requires but 7 minutes for reading and describes moisture problems and what can be done about them. Included in the booklet is a table of approximate air needs of air tools and details of a dehumidifier-filter unit manufactured by the Van Products Co. publishers of the booklet. An additional brochure on the dehumidifier-filter presents the principles of this unit which treats compressed air with a specially formulated drying agent that renders compressed air dry, clean and safe. The brochure includes a graph of dewpoint vs. air temperature, and a description of the drying agent.

Circle 253 on Reader Service Card

CYLINDER TUBING . . . which needs no further processing for most applications is featured in Bulletin R7 issued by Tube Reducing Corp. The bulletin diagrams the cold sizing process by which tapered groove dies are rocked back and forth over the tube, compressing the metal of the tube against a hardened and polished mandrel which controls the inside diameter. Compared to a cold drawing operation, the process eliminates multiple draw bench passes which have a tendency to scratch or score the inside surface of the tube. The uniformity and consistency of the closer ID tolerance permits standardization and interchangeability of the inside working parts of the cylinder.

Circle 254 on Reader Service Card

VARIABLE DELIVERY AIRCRAFT PUMPS . . . are specified in a 50-page catalog prepared by Hamilton Standard Div. United Aircraft Corp. After an introduction giving information on the development and general performance of the pump line, the catalog is devoted to specifications for eight models. Cutaway drawings show construction of the pumps, outline drawings give mounting information, and graphs show flow vs. outlet pressure. Results of endurance tests are included for the pumps which are rated for 2000 and 3000 psi. These range in rated speed from 6300 rpm with an output of 16 gpm to 11,500 rpm with an output of 2.25 gpm. Weight of this high speed pump is 4.4 lbs.

Circle 255 on Reader Service Card

Continued on page 166

Circle 80 on Reader Service Card

Circle 29 →

MIGHTY . . . SAFE!

Navy adopts Cellulube* fire resistant hydraulic fluids to safeguard aircraft elevator systems

To minimize danger from fires and explosions that might hamper the operational efficiency of its great carriers, the U. S. Navy is now using Celanese* Cellulube 220, a straight chemical compound, as hydraulic fluid to activate deck-edge elevators.

Used for more than 1,500 hours aboard the Bennington, Shangri-La and Ticonderoga, Cellulube 220 is in service aboard the new Saratoga, and is also being evaluated for additional Naval applications.

Cellulube 220 is one of a series of synthetic (non-petroleum) functional fluids developed for industry by Celanese in six controlled viscosities. These fire-resistant hydraulic fluids and cylinder lubricants provide a significant margin of safety wherever high temperatures and pressures may cause fire or explosion.

For additional information about the Celanese Cellulube series, write to Celanese Corporation of America, Chemical Division, Department 588-E, 180 Madison Avenue, New York 16.

In Canada, Canadian Chemical Company, Ltd., Montreal, Toronto, Vancouver.

DECK EDGE ELEVATOR TAKES PLANE TOPSIDE. Cellulube 220 is being used in elevators of this type on the Shangri-La, Bennington and Ticonderoga. The Navy plans to install fire-resistant hydraulic fluids on all carriers.

OFFICIAL U.S. NAVY PHOTOGRAPH

"U.S.S. Saratoga"

Basic reasons . . . . . for improved products

Acids	Functional Fluids	Polyols
Alcohols	Gasoline Additives	Plasticizers
Aldehydes	Glycols	Salts
Anhydrides	Ketones	Solvents
Esters	Oxides	Vinyl Monomers

Celanese* CHEMICALS

*Reg. U.S. Pat. Off.

Agricultural, automotive, aviation, building, electrical, paper, pharmaceutical, plastics, surface coatings, textile.

Useful Literature continued

PISTON ROD MATERIAL . . . which has a surface hardness close to 60 on the Rockwell C scale and is precision ground to standard diameters is presented in a brochure from Thomson Industries, Inc. The AISI 1060 steel rods are available in standard sizes ranging from a nominal diameter of ¼ to 4 inches with lengths from 8 to 14 feet depending on the diameter. The depth of hardness ranges from .040 inch minimum in the smallest diameter to .100 inch minimum in the largest diameter. Special machining on the ends or along the length is available, and surface hardened, long round parts which must be made of special heat-treatable alloy bars or tubes can be obtained.

Circle 256 on Reader Service Card

HOSE FITTINGS . . . Numerous styles and applications of quick couplings are illustrated and described in Bulletin No. 1475 issued by Breco Div. Perfecting Service Co. Among the various devices specified are quick connect and disconnect couplings for air hydraulic and industrial fluid service. These feature one-hand operation, small compact design, full swivel action, and integral check valve. Other fittings include double shutoff coupling, straight-through couplings, hose fittings and adaptors, hose, ferrules and crimping tools, and a rotary union air seal for conveying compressed air from a stationary pipe line to a revolving machine member.

Circle 257 on Reader Service Card

METAL O-RINGS . . . which have resistance to high temperature and pressure, less weight, thinner walls, and smaller sizes are described in a brochure from The Advanced Products Co. Low flange loading, special shapes and less seating force are advantages of the O-rings. The rings are manufactured from thin-walled tubing, precision formed, and closed by electric resistance welding. The most frequent material used is stainless steel which is titanium stabilized to prevent carbide precipitation during welding. Diagrams are included in the brochure to illustrate methods of installing the O-rings and a series of curves indicate their properties by plotting compressive load vs. deflection. Tubing diameter ranges from .035 to .125 inch.

Circle 258 on Reader Service Card

HOSE AND FITTINGS . . . A 64-page catalog has been released by Aeroquip Corp. to cover their products including high, medium, and low-pressure hose; reusable fittings; and hose couplings. The well-planned catalog also answers fluid line problems encountered by designers of machine tools, trucks, construction equipment, engines, farm equipment, and other applications. Catalog No. 200 includes a section of engineering data giving information on proper selection of hose, diagrams of correct hose installations, graphs of bend radius vs. operating pressure, and tables of thread size data, and bulkhead hole

Continued on page 168

You get 10 big Integral-Motor-Pump advantages in these two NEW types (three models) of

GAST ROTARY AIR PUMPS

Model 0211
1/6 hp, to 1.3 cfm, 23 psi or 27" vac.

Model 0321
1/4 hp, to 2.2 cfm, 25 psi or 28" vac.

Model 0521
1/3 hp, to 3.8 cfm, 20 psi or 28" vac.

*0321 similar in appearance.

1. Latest type G.E. "Form G" motors.
2. More compact than other pumps.
3. Total weight reduced 1/3—cuts shipping costs.
4. Motor mounting time and labor eliminated.
5. Simple, trouble-free rotary-vane design.
6. Vanes take up their own wear automatically.
7. Positive displacement, pulseless air delivery.
8. Improved appearance—smoother exterior.
9. Dependable for original equipment; plant use.
10. Forced air fan cooling on Models 0321 & 0521.

Write for new Bulletins V-356 and P-356! **Gast Manufacturing Corp.** P. O. Box 117-D, Benton Harbor, Michigan.

Original Equipment Manufacturers for Over 25 Years

GAST ROTARY • AIR MOTORS TO 4 H.P. • COMPRESSORS TO 30 P.S.I. • VACUUM PUMPS TO 28 IN.
See Our Catalog in Sweet's Product Design File

Circle 55 on Reader Service Card

SOLENOID OPERATED AIR VALVES

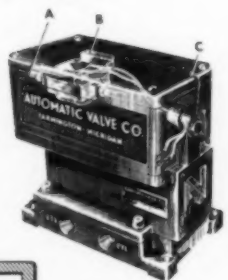
designed to

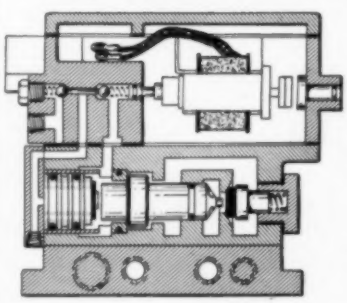
J.I.C.

standards

¼"-⅜"-½"-¾"

4-Way—Model 441





FEATURES

A—Manual Operating Button

B—Water-tight and Dust-tight Solenoid Enclosure with built-in Electrical Junction Box.

C—Cover chained to Body

Write for Information—Prices

AUTOMATIC VALVE CO.
37419 Grand River Ave. • Farmington, Mich.

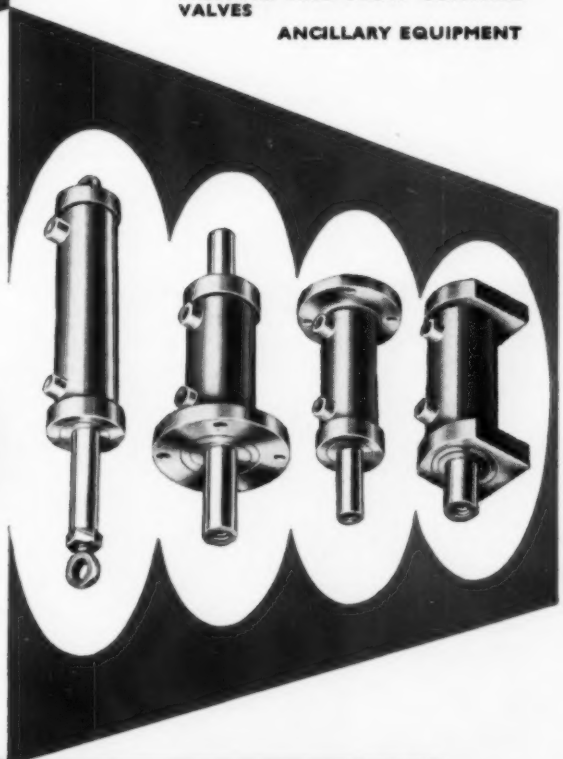
Circle 14 on Reader Service Card

QUALITY . . . in Hydraulic Power Transmission

Our sole business is the design, manufacture and installation of hydraulic power transmissions. With a first-class knowledge of our subject and a fine range of standard equipment we guarantee quality in all our work.

Put us to the test. Send along details of your own hydraulic headache—we'll prescribe a lasting cure!

HYDRAULIC PUMPS AND MOTORS
fractional to 300 h.p. 2000 p.s.i.
DOUBLE-ACTING CYLINDERS
Bores up to 6". Strokes to application
PRESSURE AND FLOW CONTROL VALVES
ANCILLARY EQUIPMENT



INSTALLATION AND PERFORMANCE DATA ON STANDARD UNITS AVAILABLE ON REQUEST

THE RECOGNISED AUTHORITY ON HYDRAULIC POWER TRANSMISSION

Keelavite hydraulics

KEELAVITE ROTARY PUMPS AND MOTORS LTD.
ALLESLEY · COVENTRY
Telephone: Meriden 441

Canadian Agent: JOHN SPOTTON CO. LTD. 21 CARSON ST. TORONTO 14, ONTARIO

Useful Literature continued

size data. Also included in this section is information on hose assembly machines manufactured by the company and a special oscilloscope for analyzing pressure phenomena.

Circle 259 on Reader Service Card

AGRICULTURAL CYLINDERS . . . are specified in catalog sheets available from Prince Mfg. Corp. The 500,600 series are utility cylinders for general use when only single action or one-way push is needed. These have welded construction and are designed for 1500 psi. The 1200,1300 series are a heavy duty double acting type for 2000 psi. With 2 and 2½-inch bore these are made with 8, 16, and 24-inch strokes. Auxiliary equipment also presented in the literature includes a stroke-limiting collar set, and a breather filter for use in conjunction with a double acting cylinder operating as a single acting cylinder. This unit filters dirt and foreign material out of the cylinder end which displaces air.

Circle 260 on Reader Service Card

LIQUID SPRINGS . . . using compressible liquid are specified in catalog LS from Taylor Devices, Inc. The units which are equal to 10 heavy duty coil springs of the same diameter, length, and stroke are compared to coil springs in relation to length, preload, maximum force, and effective stroke. Charts for three different sizes show the alteration of stroke with increasing preload. A diagram shows construction principles of the liquid spring which can be used for either tension or compression from 200 to 125,000 lbs force. By a simple change in construction the liquid spring becomes a shock absorber for damp action combined with a spring force.

Circle 261 on Reader Service Card

WELDED TUBING . . . which has been used successfully for hydraulic cylinders on agricultural equipment is outlined in Bulletin TB-362 offered by the Babcock & Wilcox Co., Tubular Products Div. The tubing is available in hot or cold rolled carbon steels, of various analyses with OD's from ½ to 4 inches and wall thicknesses from .028 to .203 inch. Lengths from 6 inches to 40 feet can be supplied. The bulletin describes an agricultural application which uses a 10-foot section of 3-inch ID tubing with an ID tolerance of +.000, —.010 inch.

Circle 262 on Reader Service Card

COUPLINGS . . . Flexible gear couplings which have only seven parts are featured in Catalog C-4 from The Sier-Bath Gear & Pump Co., Inc. The new simplified coupling absorbs misalignment and end float. It has a simplified method of closure which eliminates the need for cumbersome flanges, bolts, and nuts. Neoprene lubrication seals and steel snap rings hold in the lubricant and provide the means of assembly. End-thrust rating is 50,000 lbs. Details are given of the construction of the coupling as well as numerous examples of its application. Specifications for the standard, mill motor type, vertical shaft type, floating shaft type, spacer type, and special types are given with complete engineering data.

Circle 263 on Reader Service Card

STOP

NOISE from air, steam and gases discharged to atmosphere

PULSATION in pipelines created by surges from engines, compressors, blowers, etc. with

BURGESS-MANNING SNUBBERS

They are engineered to effectively correct your specific noise and pulsation problems. You will profit through better neighbor and employee relations and avoid compensation claims.

Write for full information.

Sound Engineering

BURGESS-MANNING COMPANY

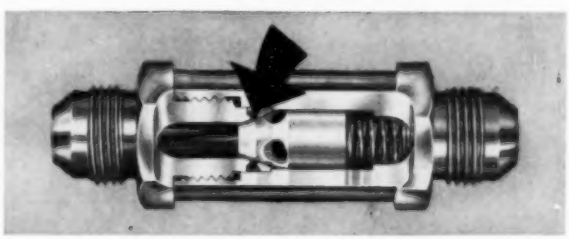
769 East Park Avenue, Libertyville, Illinois

Dallas, Texas

Circle 24 on Reader Service Card

The FLEXIBLE SEAL SEAT*

Simple, Secure, Long-Lasting!



Responsive action of the soft O-ring seal provides absolute leak-tightness. Instantly compresses to seal internal and external pressures. Draws harmlessly around dirt particles. No costly precision parts; no extra end seals. Stocked in 6 standard Dryseal pipe and JIC tube sizes; 12 connection combinations. Write for data sheet.

KEPNER PRODUCTS COMPANY

7321 West 59th Street • Summit, Illinois

Kep-O-seal

HYDRAULIC & PNEUMATIC

CHECK VALVES

* PATENT APPLIED FOR

Circle 82 on Reader Service Card

WE'RE CROWING ABOUT OUR HYDRAULIC CYLINDERS - CUSTOM BUILT AT MASS PROD. PRICES

SAVE 50%

Our 10 Years of experience filling the needs of Aircraft and Heavy Industry have led to the development of these outstanding Industrial Hydraulic Cylinders. All are Double Action with rugged steel construction throughout. Made to stand pressure up to 1500 PSI and 3000 PSI. Utilizing standard 'O' rings with leather back-up rings on 3000 PSI types. Male clevis mounts on both ends of the Cylinder. Write us Today for further information. We also Custom Manufacture to YOUR SPECIFICATIONS.

PART NO.	BORE	SHAFT	STROKE	LENGTH	Type of CAP	P.S.I.	THRUST	PRICE
P3-4-15E 3	3"	1-1/8"	4	9¾"	External	1500	10,500 LBS.	$34.25
P3-6-15E	3"	1-1/8"	6"	11⅞"	"	1500	"	36.75
P3-8-15E	3"	1-1/8"	8"	13⅞"	"	1500	"	39.50
P3-12-15E	3"	1-1/8"	12"	17⅞"	"	1500	"	44.75
P4-5-15E	4"	1-1/8"	5"	10⅝"	"	1500	18,750 LBS.	39.50
P4-6-15E	4"	1-1/8"	6"	11⅝"	"	1500	"	41.50
P4-8-15E	4"	1-1/8"	8"	13⅝"	"	1500	"	45.75
P4-10-15E	4"	1-1/8"	10"	15⅝"	"	1500	"	50.00
P4-12-15E	4"	1-1/8"	12"	17⅝"	"	1500	"	54.00
P4-5-30E	4"	1-1/2"	5"	10⅜"	"	3000	37,500 LBS.	55.25
P4-6-30E	4"	1-1/2"	6"	11⅜"	"	3000	"	57.25
P4-8-30E	4"	1-1/2"	8"	13⅜"	"	3000	"	61.50
P4-10-30E	4"	1-1/2"	10	15⅜	"	3000	"	65.75
P4-12-30E	4"	1-1/2"	12"	17⅜"	"	3000	"	69.75
INSERTED CAP TYPE								
P3-4-15-1	3"	1-1/8"	4"	11½"	Inserted	1500	10,500 LBS.	34.25
P3-8-15-1	3"	1-1/8"	8"	17½"	"	1500	"	39.50
P5-12-30-1	5"	2"	12"	21½"	"	3000	59,250 LBS.	85.00
P5-18-30-1	5"	2"	18"	27½"	"	3000	"	97.50
P5-24-30-1	5"	2"	24"	33½"	"	3000	"	115.00
P5-30-30-1	5"	2"	30"	39½"	"	3000	"	135.00

EXTERNAL CAP TYPE

INSERTED CAP TYPE

4-WAY, OPEN CENTER HYDRAULIC CONTROL VALVE

NEW

Has built-in adjustable relief valve, set at 1000 PSI with a spring loaded neutral position. Used for controlling (1) double action cylinder of the types shown in this advertisement. Can also be mounted in series. Has 3/4" standard pipe inlet & outlet ports. 1/2" pipe thread cylinder port. Shipping weight 10-1/2 pounds. . . . . **21.50 NEW**

NEW - HEAVY DUTY HYDRAULIC CYLINDER

A rugged, heavy duty cylinder. All steel construction. Double action. Has 7" bore, 13" stroke, 2½" steel shaft. Ideal for use in hydraulic presses, leveling ramps, hydraulic tail gates, industrial machinery, road machinery, etc. Shipping weight 180 pounds **95.00**

SAVE UP TO 85% ON GOV'T SURPLUS HYDRAULICS

SURPLUS HYD. CYLINDERS

Gov't Surplus Bargain. Produces up to 40,000 lb. thrust with a 3000 PSI line pressure. May also be used as a low pressure air system cylinder. Has a 4" bore, 18" stroke, 30½" length. Part No. 29. New & Used.

NEW **43.95** USED **29.95**

Part No. 27A. Finest Surplus. For use up to 1500 PSI. Has bore of 3½", stroke 21-5/8", shaft 1", Length 29⅛". Ports 3/8" AN pipe. **35.77**

Part No. 27B. Similar to above. Will stand up to 2000 PSI. Has internal stroke cushion in both directions. Bore 3-7/8", stroke 23", shaft 1-3/8", eye-to-eye length closed is 40-3/4". Ports are 1/2" AN pipe. **45.00**

Part No. 27C – Similar to 27A above. Take up to 1500 PSI. Has 3-1/2" bore, 23" stroke, 1-1/2" shaft, 34" closed lgth. 1/2" AN pipe ports. **45.00**

TELESCOPING HYDRAULIC CYLINDER

Thrust shaft is in two stages. First stage extends 39" – the second stage extends 18". Each stage works seperately. The overall length eye-to-eye is 61½". Inner shaft is 2-3/4" dia. outer shaft is 3¼" dia. Bore is 4¼". Ports are 1/2" AN pipe. **165.00**

10,000 PSI HAND PUMP AND RESERVOIR **19.75**

For use with a short stroke press or as a static pressure booster pump. Reservoir mounts vertically with a capacity of 45 cu. inches. Has two position handle. . .

HYDRAULIC HAND PUMP – Has 1500 PSI operating pressure. 1.5 cu. inch capacity per complete cycle. Top condition. **12.75**

4-WAY BANK VALVE

A Bank Valve containing four 4-way poppet type valves. Complete unit has a common inlet and outlet with a built-in relief valve and metering valve. The 4-way valves are independently controlled – pressure balanced with a neutral position. Ports are 3/8" AC tube (9/16"-20 thread **22.50**

SURPLUS VICKERS PISTON TYPE-CONSTANT SPEED-HYD. PUMPS & MOTORS

Made to top Aircraft specifications. RPM shown below is the recommended maximum for constant speed. Quantities limited.

HYDRAULIC PUMPS					PRICES	
Part No.	Cu. in. per rev.	GPM	PSI	RPM	NEW	USED
PF9-713-20BCE	.410	5.3	1000	3000	—	$20.00
PF9-2713-20ZE	.410	5.3	1500	3000	$24.50	—
PF9-2713-10Z	.208	2.7	1500	3000	—	$22.50
PF2-713-25BCE	.507	6.5	1000	3000	$32.50	$22.50
HYDRAULIC MOTORS						
MF9-713-15A	.310	4.46	1000	3750	—	$18.50
MF10-713-30B	.600	9.75	1000	3750	$57.50	—
MF9-713-25BCF	.507	8.25	1000	3750	—	$22.50

180° OFFSET DRIVE

For use where tremendous power at a low take-off RPM is desired. Has 6 gears rotating on self-lubricating, hi-speed roller bearings. 85 to 1 gear ratio. Shafts are 1/4" and 3/8" in diameter. USED . **5.95** NEW – in excellent condition. **8.95**

HYD. HOSE & TUBING

We stock a complete line of Hydraulic Tubing and Hose as well as all types of fittings and hardware. Send us your requirements.

STRATO POWER HYDRAULIC PUMPS

Designed and built to finest aircraft specifications.

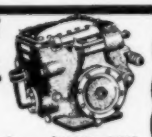
PART NO.	GPM	PSI	RPM	PRICE EA.
SP-3	2	1400	3750	NEW $27.50
P3C	20	1500	3750	NEW $125.00

Order from this Ad. Pay by Money Order or Check. P.O.s accepted from well rated D&B firms. 1/2 Dep. with C.O.D.s. Prices F.O.B.

Palley SUPPLY CO.

2263 E. VERNON AVE., DEPT. AH-5 LOS ANGELES 58, CALIFORNIA

VICKERS AA 20328 HIGH PRES. PUMP



Automatic, variable volume of 1850 to 2000 PSI continuous operating pressure. Has a continuous speed of 3750 RPM maximum. Displacement is .600 cu. in per rev. Will deliver up to 9.2 gallons per min. at 3750 RPM. Rotates right hand only. Will operate in any position, but top case drain must be connected to reservoir. Reservoir must be pressurized. Parts are 1" AN inlet and 5/8" AN outlet. . . . . ONLY **129.00**

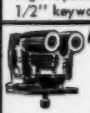
SURPLUS VICKERS HYDRAULIC TRANSMISSION

Self-contained, constant torque at all speeds with variable volume, reversible piston pump which supplies hydraulic motor. Has 2 H.P. automatic pressure dash pot for smooth control. Power output RPM is 0 to 1/3 input RPM in both directions. Input RPM 1800 continuous, 4000 intermittent. Ideal for Lathes, Duplicator set-ups, Conveyors, Drives, etc. . . . **49.50**

4" SPLINE SHAFTS for input and power take-off on above. $2.50 pair

INPUT & TAKE-OFF PLATE ASSEM. To adapt trans. to pulley drive. Has high speed bearings and 1/2" keyway shaft. Per Set **20.00**

PESCO HYD. PUMP



A gear type pump. Will deliver 2 GPM at 1500 RPM with 1500 PSI – delivers 6 GPM at 4300 RPM with 1500 PSI. Has .375 cu. in. displacement per rev. Ports are 3/4" standard pipe. 5/8" male spline drive shaft. 4" pad mount. In good condition. **14.95**

NEW HYDRAULIC CATALOG

Showing our Complete line of New and Surplus Hydraulic Supplies and Equip. Includes Cylinders in 106 sizes and types. All types Valves, Fittings, Pumps, Hyd. Motors, etc. Write TODAY!

Post Scripts of Industry

News about people, manufacturers and sales organizations

C. A. Thomas
Stratoflex, Inc.

Glen R. Larson
Hydraquip Corporation

Loren Gillhouse
Quincy Compressor Co.

C. A. Thomas has been promoted to general sales manager of **Stratoflex, Inc.** Thomas, who joined Stratoflex in 1950, will continue to work from Fort Worth, where he formerly served as sales engineer. He will now have charge of all sales activities of the organization.

Glen R. Larson has joined the staff of the **Hydraquip Corporation,** and will handle the Dallas, Ft. Worth and Oklahoma area. Until recently he was associated with United Machine Company as chief engineer in design and development projects on aircraft, oil field projects and special machinery. He has also had experience as design engineer of aircraft frame structures, hydraulics, tooling and machine design.

Stillman Rubber Co. has acquired **Extruded Products Co.,** producers of extruded rubber products for aircraft and other industries. The new acquisition will be operated as the Extruded Rubber Division. **V. L. Neschke** continues as vice president and general manager of the new division and **Joel Bush** was named vice president in charge of production.

Promotion of **Loren Gillhouse** to sales manager of **Quincy Compressor Company** has been announced. For the last five years he was assistant sales manager, and also served as regional sales manager.

Techneering Sales, Inc., 53 Park Avenue, Dayton, Ohio, was formed to take over the southwest Ohio sales activities of **Jack Dustman & Associates. Robert Kilian** will manage this office.

Four members of **Marquardt Aircraft Company's** engineering staff, **Don L. Walter,** vice president-engineering, **John A. Drake,** director of long range plans and research, **R. T. Dungan,** project engineer and turbojet controls, and **William J. Bennet,** thermodynamics engineer, were named to serve on technical subcommittees of the National Advisory Committee for Aeronautics during 1956.

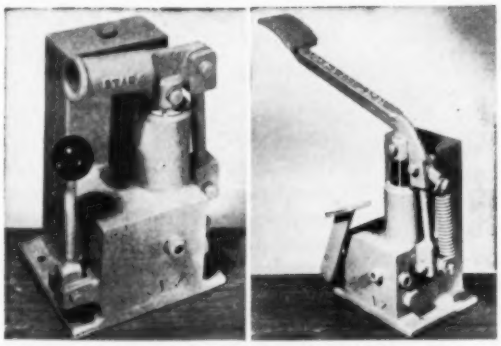
John W. Breitmayer has succeeded Alfred H. Klepfer, who has retired, as sales manager of the **Hallowell Collar Division at Standard Pressed Steel Co.** Breitmayer has been assistant sales manager since 1953.

To handle increased sales volume **Clark Controller Company** has created a marketing division, headed by **E. R. Jung,** as vice president in charge of marketing. This division will include sales, advertising, application engineering, new products development and related activities. **Robert Whitehill,** formerly assistant general sales manager was promoted to general sales manager, and **W. R. Heckman** from the

Continued on page 172

Circle 139 on Reader Service Card

STAR Hi-Lo TWO SPEED CONCENTRIC PUMPS



HAND OR FOOT OPERATED WITH SINGLE LEVER OR PEDAL

Two speed construction provides automatic change-over during operating cycle from high speed low pressure to low speed high pressure.

MAXIMUM CAPACITY 10,000 P.S.I.

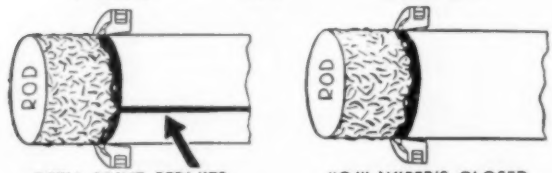
Safety overload valves—Hard chrome plated pistons—Piston stroke 1½ inch—Oil capacity 150 cu in or larger—5 models: (½"-⅞"), (½"-1¼"), (½"-1½"), (⅝"-1½"), (½"-2¼").

Special engineering counsel and proposals cheerfully submitted on request. Ask for Catalog #555.

Representative areas available

STAR JACK CO., INC.
PLANT: RIVER GROVE, ILLINOIS
SALES: 420 LEXINGTON AVE., N.Y.C. 17

This or This?



OPEN JOINT PERMITS A STREAK OF DIRT AT JOINT OPENING

"CJ" WIPER'S CLOSED JOINT KEEPS THE ENTIRE ROD CLEAN

For those dry operations requiring absolute freedom from dust or dirt passing through joint or ring to bearings or packings, we have especially designed—the

FALL WIPER RING with Closed Joint

(our P/N-FWR-CJ)

In addition to the above, and since 1944, we have also manufactured **For Army and Navy Use** the 3 Piece **FALL WIPER RING FWR-3C**

Spec Mil-S-5049, AN Approved, Military part numbers from AN6231A1, ⅛", to AN6231A71, 13", diameter. This ring consists of 3 pieces assembled into one . . (1) a one-piece Split Wiper Ring (Body) with 2 flanges or groove in its O.D.; (2) a one-piece split compressor spring assembled in groove (3) an endless cover band surrounding spring in groove which causes squeeze grip action on piston rod.

Squeeze Grip Action Does It—patented

—and squeeze grip is always the same because uniform tension of spring under endless cover band. Rods or pistons do not stick or become immobile in ANY temperature.

Our engineers will gladly work with you on any wiper ring problem. Write, wire or phone us.

Ace Products Co., Toledo 1, Ohio
Phone Cherry 36513

Fall Wiper Ring SPRING LOADED

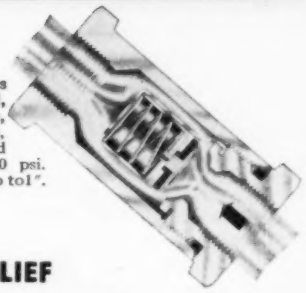
Covered by patents issued and patents pending.

REPUBLIC VALVES

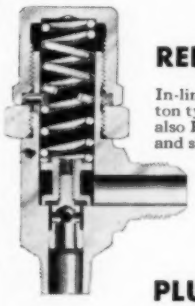
INDUSTRIAL • CHEMICAL • AIRCRAFT

CHECK

Quality Check Valves of several types—ball, poppet, Hy-pressure, Free-flow—all metals, various portings, and pressures up to 3000 psi. Pipe and tube sizes up to 1".



RELIEF

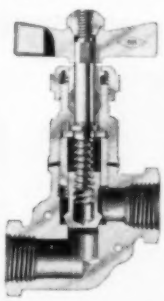


In-line and guided piston type Relief Valves, also Pilot Operated, with quick unloading and silent operation. Metal or rubber seal. ⅛" to ¾" pipe or tube port connections. Various metals.

PLUG

Precision-made Plug Valves for wide general use in brass, aluminum alloy, or stainless steel, ⅛" to 1", +32° to 160°F. With Teflon plug, −65° to 250°F, without lubrication. Aluminum alloy or stainless steel.

GLOBE AND NEEDLE



Super duty shut-off valves, angle and offset, for up to 3000 service, ⅛" to 1". Also high pressure Needle Valves for 10,000 psi. working pressure—proofed at 25,000 psi. One piece, stainless steel, ⅛" to ½", Teflon packing.

LO-TORQ SELECTOR

Directional flow control for service up to 6000 psi. Balancing principle uses line pressure to make turning easy with short handle. 2, 3, 4-way, with various drillings. Side, bottom, and sub-plate porting. Panel mounting.

Ask for new catalog, No. 654, showing entire line.

Distributors in principal cities coast to coast.

CHECK RELIEF PLUG GLOBE NEEDLE

RM REPUBLIC MANUFACTURING CO.
15655 BROOKPARK ROAD • CLEVELAND 11, OHIO

Post Scripts of Industry

continued

company's Cleveland sales office has been named to the newly created position of manager industry sales. Another new position, director of education and training was filled by **Victor Macha.**

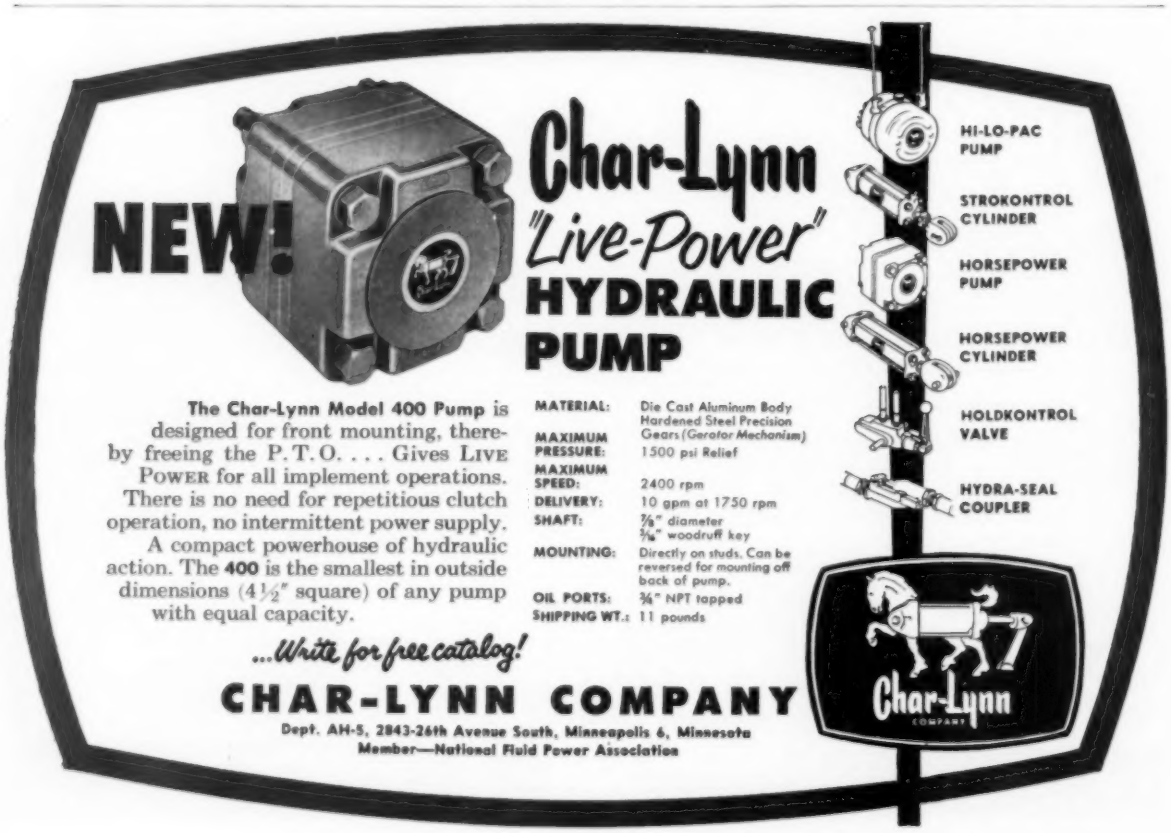
The Paul-Munroe Company, distributors of air and hydraulic equipment have moved their facilities to expanded quarters at 6430 East Gage Avenue, Bell, California.

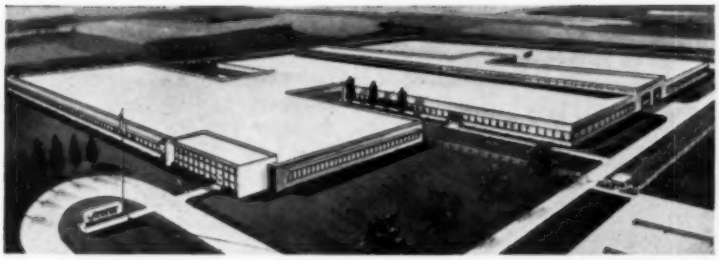
Aircraft Products Co. has acquired **Tactair, Inc.,** as a wholly-owned subsidiary which will be operated as a division of the company. All activities of the new division will be carried on from the main plant in Bridgeport, Pa. **Elwood M. Hunt,** general manager of Aircraft Products Co., has been appointed president of Tactair.

Charles H. Schreyer, recently elected president of **Darling Valve & Manufacturing Company** announced the following changes in the organization: **Carl H. Simon** was promoted to the position of vice president and general manager and will assume full responsibility for all operations. **Dick F. Sable,** formerly southwest regional manager and with the company since 1945, has become general sales manager. He will retain his offices in Dallas. **Thomas C. Jester** was named chief engineer. **James N. Elwood,** former plant manager and general superintendent, was promoted to manager in charge of manufacturing. **Packer B. Young** was appointed assistant sales administrator.

Carl H. Simon
Darling Valve & Mfg. Co.

Dick F. Sable
Darling Valve & Mfg. Co.


NEW!
Char-Lynn
"Live-Power"
HYDRAULIC
PUMP
The Char-Lynn Model 400 Pump is designed for front mounting, thereby freeing the P.T.O. . . . Gives LIVE POWER for all implement operations. There is no need for repetitious clutch operation, no intermittent power supply. A compact powerhouse of hydraulic action. The 400 is the smallest in outside dimensions (4½" square) of any pump with equal capacity.
MATERIAL: Die Cast Aluminum Body Hardened Steel Precision Gears (Gerotor Mechanism)
MAXIMUM PRESSURE: 1500 psi Relief
MAXIMUM SPEED: 2400 rpm
DELIVERY: 10 gpm at 1750 rpm
SHAFT: ⅞" diameter ¾6" woodruff key
MOUNTING: Directly on studs. Can be reversed for mounting off back of pump.
OIL PORTS: ¾" NPT tapped
SHIPPING WT.: 11 pounds
...Write for free catalog!
CHAR-LYNN COMPANY
Dept. AH-5, 2843-26th Avenue South, Minneapolis 6, Minnesota
Member—National Fluid Power Association
HI-LO-PAC PUMP
STROKONTROL CYLINDER
HORSEPOWER PUMP
HORSEPOWER CYLINDER
HOLDKONTROL VALVE
HYDRA-SEAL COUPLER
Char-Lynn
COMPANY



A new administrative and engineering center of **Vickers Incorporated** has been completed in suburban Detroit. Devoted entirely to research, development, engineering, sales and administration, the new facility covers 150,000 square feet. Included in the new building are greatly augmented research and engineering laboratory facilities. Technical activities occupy the major portion of total floor space. The new facility has presently a working force of 700.

Unimax Switch Division, The W. L. Maxson Corporation, have moved their operations to Ives Road, Wallingford, Connecticut.

Loewy-Hydropress, Division of Baldwin-Lima-Hamilton Corporation, has named **Carl Haugh** as district sales manager, rolling mill equipment, with headquarters at the company's Pittsburgh offices. Haugh has had many years experience in the field of rolling mills and other steel mill equipment.

Donald W. Irwin has been named assistant chief design engineer for **Weston Hydraulics, Ltd.,** a subsidiary of Borg-Warner Corporation. Irwin was formerly with McDonnell Aircraft Corporation and Curtiss-Wright Corporation.

Continued on next page

Circle 73 on Reader Service Card

HUSCO
Hydraulic Controls are COMPACT

Another example of Husco space-saving, this Lever-Operated Check Valve is designed for efficient and positive cylinder lock in hydraulic brake line circuits and similar applications. Small, sturdy, low in cost, it has a Hi-Chrome alloy cast iron body for extra strength, with all parts subject to corrosive action Hard Chrome plated.

Check HUSCO *first* for modern Hydraulic Units, and engineering assistance on all your hydraulic developments. Write for details.

HUSCO HYDRAULIC UNIT SPECIALTIES CO.
Pumps • Valves • Cylinders
Waukesha, Wis.

The right gauge for your product
...is in the MARSH CATALOG

Turn the pages of this catalog, and you'll know why the most discriminating manufacturers equip their products with Marsh instruments.

Hundreds of types, styles, mountings and ranges are covered; all share one common attribute . . . the best and most economical you can buy for a given set of design and service conditions.

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corp.* Dpt. 19, Skokie, Ill.
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd Street, Edmonton, Alberta, Canada

GRESEN HYDRAULICS

VANE PUMPS
With Dual Vane Feed

For Mobile, Industrial, Agricultural Uses

SPECIFICATIONS
3-6-9-12-16-20-24 G.P.M.
Max. 2000 R.P.M.

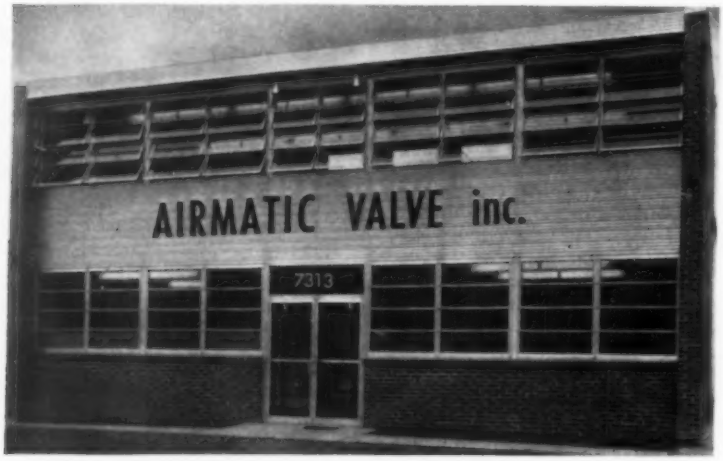
ROTATION
Clockwise-Counter Clockwise
Mounting Feet Available

Write for literature

GRESEN MANUFACTURING CO.
628 Colfax Ave. N. Dept. H-16 Minneapolis 11, Minn.

Post Scripts of Industry

continued



Airmatic Valve Inc., have moved to new quarters located at 7313 Associate Avenue, Cleveland. According to Lawrence Gardner, founder of the firm, the new structure has tripled the company's facilities. It will enable the increased engineering staff to prepare for additional product items in the valve field. The engineering department is headed by Henry Gardner.

James P. Malmstrom was named general manager of **United Aircraft Products, Inc.** He will be in charge of the Dayton, Ohio, facilities and will coordinate the increased activities of their expanding operations. Malmstrom has had wide experience in the aircraft industry pertaining to the administration of production, engineering and sales.

Frank Ross, assistant to the vice president-sales, was elected to the board of directors of **E. F. Houghton & Co.** Ross joined the company in 1942 as manager of lubrication sales. Officers re-elected include **A. E. Carpenter,** chairman of the board and **William F. McDonald,** president. Board members re-elected were A. E. Carpenter, William F. MacDonald, D. J. Richards, Dr. J. T. Eaton, Mrs. A. E. Carpenter, J. F. Maisch, C. H. Butler, H. B. Fox and D. C. Miner. Three new managerial appointments were also announced. **Charles A. Biller** has

Continued on page 176

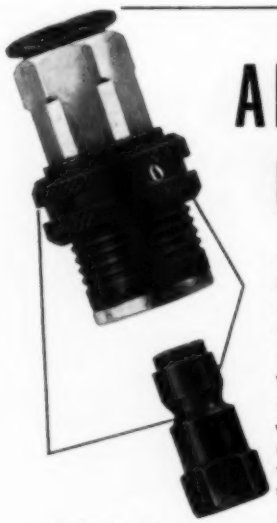
Get high power at low cost with the 10-gallon DT-10, a

Here's the complete power unit for heavy-duty, light-cycle work, such as actuating transfer machines. Using a 2 HP electric motor, the DT-10 will deliver 8 GPM at 350 PSI, 5 GPM at 550 PSI, 3 GPM at 850 PSI, and 1½ GPM at 2000 PSI.

The DT-10 is offered with ½, ¾, 1, 1½, or 2 HP electric motors. The unit includes a 2000 PSI vane-type pump and a pilot operated ventable-type relief valve, mounted on a JIC 10-gallon reservoir. It has a heat dissipation capacity of ¾ HP, and is available with panel mounted valves. Write for information today.

Attention Dealers—write us for more information.

The ROSAEN COMPANY
P.O. BOX 195 • ST. CLAIR SHORES, MICHIGAN



Designed for use on industrial steam installations where there is rough usage and extreme temperatures

AIR-STEAM COUPLERS

- Heavy duty combination coupler for air or steam lines
- Available in three body sizes with pipe threads from ⅛" to ¾"
- Used on steam installations up to 180 lbs or 380°F
- Couplers are small, lightweight, yet capable of passing a maximum amount of steam or air with a minimum amount of pressure drop
- ¼" and ⅜" series made with or without sleeve safety rings
- Matching nipples available for all size coupler bodies

WRITE FOR CATALOG SHEETS

TRU-FLATE, INC.
888-92nd Avenue • OAKLAND 3, CALIF.

Circle 126 on Reader Service Card

Circle 145 on Reader Service Card

Circle 138 on Reader Service Card

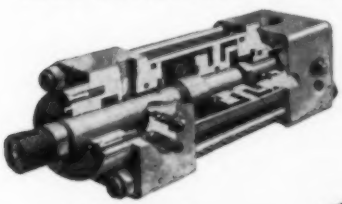
specify standard UNBRAKO Dryseal-Thread Pressure Plugs

Use them in place of ordinary pipe plugs, or wherever liquids and gases must be contained under pressure. UNBRAKOs seal without compound. They are made of the same high strength alloy steels, have fully formed threads and the same internal wrenching feature as other UNBRAKO socket screws. Standard sizes—1/16" to 1 1/4"—are stocked by authorized industrial distributors. Ask your UNBRAKO supplier for Bulletin 883. Or write STANDARD PRESSED STEEL CO., Jenkintown 2, Pa.

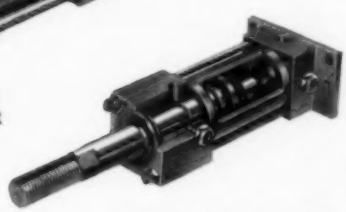
UNBRAKO SOCKET SCREW DIVISION **SPS** JENKINTOWN PENNSYLVANIA

PETCH CYLINDERS

meet J.I.C. & NC-I STANDARDS *providing* "MOTOVATION for AUTOMATION"



☐ TIE-ROD Design
Low Pressure Hydraulic 500 psi—1½"-10" bores; High Pressure Hydraulic 1500 psi 1½"-6" bores; Air 200 psi—1½"-10" bores



☐ AUTOMOTIVE heavy duty AIR
200 psi—1½"-6" bores

☐ BOOSTERS
Drive Cylinders 4", 5", 6", 8" bores Ratios 5:1 to 28.5:1

☐ TANKS
4"-10" bore sizes

Petch Hydraulic Devices include:

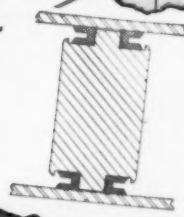
☐ HUPP Threadless Sub-Plates—Inserts & Swivel Fittings
☐ Limit Switch Actuator
☐ Oil Tank Sight Gauge

Send for catalog regarding the product or products for which you have use—each one includes complete specifications and engineering data. The complete PETCH portfolio consists of 96 pages of hydraulic and pneumatic information.

PETCH 465 York, Detroit 2 **MANUFACTURING COMPANY**

Circle 113 on Reader Service Card

DESIGN NOTES—



PALMETTO U-RINGS replacing Cup Packings

New trend simplifies piston design... reduces machining costs... facilitates installation... reduces friction

Here's proof that it works

A well-known manufacturer of welding machines ran a life test on a 9" air cylinder. Palmetto U-Rings 2620-172-A kept the cylinder operating at 96% efficiency, were in excellent condition after 9 million cycles...did a better job than 5 competitive makes! Now, after 2 years of use in production-made air cylinders, Palmetto U-Rings are still doing an excellent job.

Rectangular design of Palmetto U-Rings increases stability and strength and eliminates rolling in groove. Rugged, with wide lip flare for use in cylinders made from commercial tubing honed up to .030 over nominal sizes. Same sizes available in synthetic or fabric construction permits interchangeability of packing in low or high pressure cylinders. ALLOWS STANDARDIZATION OF COMPONENT PARTS... INCREASES EFFICIENCY.

It will pay you to redesign with Palmetto U-Rings. Write for information or ask our salesman to call—at no obligation

GREENE, TWEED & CO. NORTH WALES, PA.

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Circle 114 on Reader Service Card

HAND HYDRAULIC PUMP

Single and Double Designs
to 20,000 PSI
With or Without Reservoir
Standard Reservoirs
70- 160- 910-Cu. In. Capacity
Interchangeable Pistons
⅜ - ½ - ¾ Inch
1-inch Piston (Special)
Pipe connections ¼" N.P.T.
Handle length is 18 inches.
"We specialize in hand pump units to operate in temperatures from minus 65 F to plus 160 F and with any capacity reservoirs required."
The single pump with ½" or ¾" piston now available in stainless steel.

WILLIAM S. PINE
1635 E. 22nd St., Los Angeles 11, Calif.

Post Scripts of Industry
continued

become manager-foreign sales department. **Armand J. Andre,** previously with the company's Chicago sales division, was named assistant sales manager of the Southern division, with headquarters in Charlotte, N. C. **William Eisman** was appointed acting research manager.

Ted H. Holzer
Roylyn Incorporated

Ted H. Holzer has become assistant chief engineer of **Roylyn Incorporated.** Holzer joined the company in August 1954 as administrative engineer. His duties will include direct supervision and responsibility for the design section and the overall direction of the research and development program. He will also be responsible for the performance of the technical data and record section through the technical service engineer and sales production liaison activities.

Three-day workshop sessions were recently held for sales representatives of the Manhattan Rubber Division and the Packing Division of **Raybestos-Manhattan, Inc.** The meetings, held at the Lake Shore Club, Chicago, brought together representatives

Continued on page 178

HONED Stainless Steel ROD ...at

NO extra cost

At no increase in price, **AIROYAL** small (1", 1½" and 2") bore air and oil cylinders—always a good buy—have been even further improved. You'll buy them now with satin-smooth, externally honed, stainless steel piston rods. No more rust on rods, pitting or other surface imperfections. You'll enjoy the substantial increase in rod packing life. And look—price of 1" x 1" cylinder, for 150 PSI air or 1500 PSI oil service, is still only $27.00 list. **Write for catalog and prices.**

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THE AIROYAL CO.
1990 SPRINGFIELD AVENUE
MAPLEWOOD, N. J.
REPRESENTATIVES IN PRINCIPAL CITIES

HOSE HAPPY?

Mayson Hose Swivels

are spreading smiles among hundreds of hose users. By eliminating twist strain Mayson Swivels allow hoses to perform their normal purpose—that is to bend and bend only.

Call your Mayson Dealer or write us, a catalog is yours for the asking.

J.I.C. Standards
Sizes ¼" to 2" P.T.
Male or Female

MAYSON MFG. CO.
4332 Horatio Street • Detroit 10, Mich.

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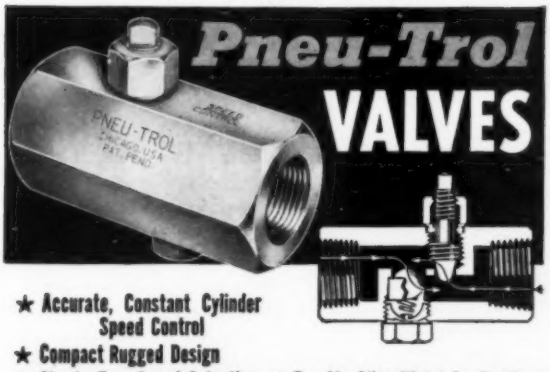
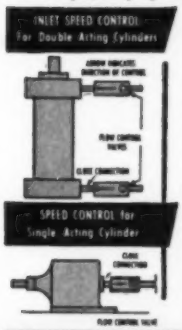


★ Accurate, Constant Cylinder Speed Control
★ Compact Rugged Design
★ Simple, Easy Speed Selection ★ For Air, Oil or Water Applications



Pneu-Trol Speed Control Valves, are widely used in hundreds of control applications because they combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to its seat, requiring only a slight differential pressure to fully open or close it.

Needle design permits maximum flow capacity in the controlled direction. Metal to metal needle and ball seats insure long trouble-free service. Simple, practical "O" gland structure eliminates troublesome leaking. Valve bodies machined from hex brass or aluminum for 2000 psi working pressures; steel and stainless steel for 5000 psi. Made in 5 female pipe sizes—⅛" to ¾". ATTRACTIVE PRICES . . . IMMEDIATE DELIVERY.

Write for illustrated circular and prices.

Pneu-Trol DEVICES, INC.
1426 N. KEATING AVENUE • CHICAGO 51, ILL.

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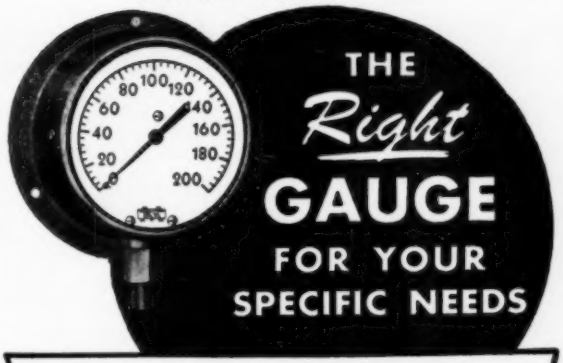

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• Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

WRITE TODAY FOR COMPLETE INFORMATION

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800 East Nevada St., Marshalltown 4, Iowa

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A complete packing unit for hydraulic or pneumatic rods or cylinders.

- Easily installed or replaced.
- Needs no adjusting.
- Reduces initial machining expense.
- Longer service life.
- Includes "Seal-Guard" rod wiper.
- Low friction coefficient.
- Shock and burst proof.
- Cuts machine down-time.

*Detailed literature on request.

HYDRAULIC ACCESSORIES CO.
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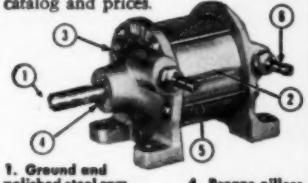
Circle 4 on Reader Service Card

AIR-MITE AIR CYLINDERS

Low Cost . . . Compact . . . Powerful . . . Rugged

AIR-MITE Cylinders—made in single or double acting series—in 4 mounting types, are high quality cylinders at a low price. Simple, rugged design and compact construction give them long life, permit easy mounting on jigs, fixtures, tools, or machines. Used wherever power holding, pushing, pulling or lifting is required, AIR-MITE cylinders will meet your most exacting standards of dependability and long life. Write for complete catalog and prices.



1. Ground and polished steel ram
2. Brass, true-bore cylinders
3. High strength aluminum alloy cylinder heads
4. Bronze oilless ram bushing
5. Five steel tie rods
6. Brass hose stems

4 Mounting Types

AIR-MITE Devices, Inc.
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Post Scripts of Industry

continued

from all districts. The program was arranged by **R. B. Hazard,** sales manager for both divisions, assisted by **John McKinlay,** assistant sales manager, packing division. Factory engineers from the corporation's various plants led discussions on rubber, packing and Teflon products. **John F. D. Rohrbach,** president, highlighted the progress of the company and its divisions and discussed future plans for expanded sales.

Appointment of **John B. Borah,** as district sales manager for the Kansas, Missouri and Texas area, with headquarters in Wichita, has been announced by **The Weatherhead Company. Sidney C. Howell** has become eastern sales manager for the company's Aviation Division.

Two new agents have been appointed by **The A. W. Cash Company. Hurston-Conaway, Inc.,** with offices in Memphis, and branch offices in Nashville and Little Rock, will cover the western two-thirds of Tennessee and northeastern quarter of Arkansas. **Thermal Engineering Co.,** Salt Lake City, Utah, will cover the whole state of Utah.

Charles T. Tinsley
Thermoid Company

J. A. Muller has been promoted to technical manager of the rubber division of **The Thermoid Company.** Formerly executive engineer of the division, he will now supervise all research and development. **Charles T. Tinsley** was named assistant sales manager of the industrial rubber division. He was previously manager of Thermoid's southeastern division.

J. A. Muller
Thermoid Company

Continued on page 180

Clamp Hydraulically and Slash Fabrication Costs!

Simple Units
Inexpensive
Equal Pressure at all Points
No Distortion
Instant Clamp Release

NEWTON PRODUCT
CLAMP
Hydraulic MULTIPOINT

For MILLING
GRINDING
WELDING
GLUEING
and every other clamping problem

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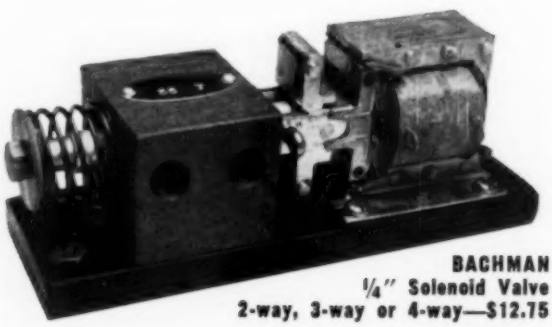

BACHMAN
¼" Solenoid Valve
2-way, 3-way or 4-way—$12.75

If you are looking for low cost dependability here is a constant duty direct solenoid valve for 200 psi with ¼" orifice—at a price below most hand operated valves. The body is machined from tough canvas base phenolic with ports perpendicular to the laminations.

These valves give millions of cycles of quiet and trouble-free service because the resilient construction *quietly* absorbs the kind of punishment that damages harder materials.

Stems are hardcoated aluminum and permanently resist wear or abrasion. Seals are standard O-rings.

With these units you can operate, check or cushion air cylinders. In air-hydraulic systems they will provide positive check or dwell. Use them for many combinations of manual or automatic control. The valve illustrated is 7" long, weighs 2 lbs. and mounts in any position. Other models have double solenoid and also hand, foot or mechanical actuation. All have ½" stroke with spring return optional.

Let us mail you complete literature or ask us to send you one of these units for a 30 day test and decide for yourself whether this long life leakproof valve can save you money.

JOHN D. BACHMAN & CO.
1713 Sperger Lane Bristol, Tennessee

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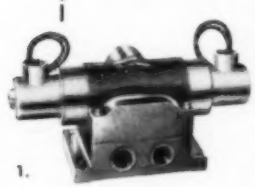
Modernair

MV CONTROL VALVES

Easier to apply... Compact, versatile; choice of 3 mountings and 7 manual, solenoid, cam or pilot operating means for pneumatic, hydraulic systems to 200 p.s.i.

Easier to install... Sub-base, console and panel, or conventional piped mountings available. Made in ⅜", ½", ¾" and 1" NPT port sizes.

Easier to service... Only moving part is one-piece spool carrying all moving seals which are standard "O" rings stocked by industrial supply houses; replaceable in minutes—no springs or retainers.



1. 4-way double solenoid MV is only 9¾" x 3½" x 2⅝" overall (½" NPT ports); handles to 150 p.s.i.

Don't lose time and money with misfits or specials when a stock MODERNAIR MV valve will do your job. Modernair valves, cylinders and parts are stocked in principal U.S. and Canadian cities, and at factory. For prompt delivery, call your authorized dealer or write us now for specifications and prices.

Modernair CORPORATION

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PROTECT PRESSURE-SENSITIVE INSTRUMENTS . . . POSITIVELY

GG gage gard

Seals off gage or manometer connection at any pre-set pressure. Will repeat within 1% of scale. Will release 2% below cut-off point.

Models available with cutoffs from 20" water to 9000 psig. liquids and gases. Designed to withstand and hold closed against 10,000 psig.

Marine models available.

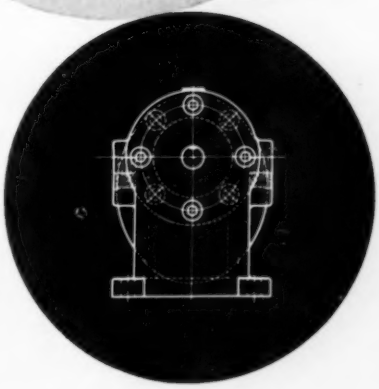
Write for Bulletin 541-G for full details and prices.

INDUSTRIAL ENGINEERING CORPORATION

525 E. Woodbine, Louisville, Ky.

Unlimited Mounting Possibilities

. . . with these pumps for pressures up to 500 psi



When mounting pumps, foot position may be varied in relation to ports at 90° stages through a complete circle.

You can meet practically any mounting requirement with pumps in the Brown & Sharpe 500 Series. Compact flanged stand and separate foot-type bracket make installation easy in any position . . . allow quick adaptation for duplex and motor-drive units. Suction and discharge ports on both sides and ends of pumps facilitate piping. In addition, you get such top-performance features as quiet-running hardened gears, long-lived needle bearings and mechanical sealing . . . for positive, trouble-free service. Write for New 70-page Pump Catalog 35P. Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.

B·S

BUY THROUGH YOUR LOCAL DISTRIBUTOR

Brown & Sharpe

Post Scripts of Industry
continued

Stillman Rubber Co., Culver City, Calif., has started construction of an 8000 square feet, two-story warehouse and office utilities building adjacent to their main plant.

Skinner Chuck Company and Skinner Electric Valve Division appointed **George Geopfrich** as director of engineering and development, and **Robert B. Clay** as chief engineer of the Electric Valve Division. Geopfrich was previously chief engineer of that division. He is a member of the valve rating committee of the National Fluid Power Association. Clay was formerly assistant chief engineer.

George Goepfrich
Skinner Electric Valve Div.

Robert B. Clay
Skinner Electric Valve Div.

R. P. Adams Company, Inc., have named the **Chem-Quip Company,** Pensicola, Florida, as their representative for the western portion of Florida, the state of Mississippi, the southern section of Alabama and the southeastern part of Louisiana. **Paul A. Chapman & Associates,** Adam's representatives with offices in Johnson City and Chattanooga, Tenn., had their territory extended to include the northern half of Alabama, the western part of South Carolina, the southwestern tip of Virginia and all of Tennessee.

Paul Kushubar and **Wesley Pontier** have been added to the sales engineering staff of **Raybestos-Manhattan, Inc.,** under chief engineer Guy E. Horvath. Kushubar has been for the past five years a project engineer at RM's Bridgeport plant working on development and processing procedures. Pontier has been associated with the rubber division for 15 years and recently had experience in production and methods procedure.

MECHANICAL ENGINEERS:

A Career at Electric Boat... Is An ADVENTURE in Engineering

In the past several years, Electric Boat has been making one headline after another as the nation's first adaptor of nuclear power for propulsion. The Electric Boat-designed and built atom submarines, Nautilus and Seawolf, are already accomplished fact.

Behind the headlines, the work of designing even more advanced atomic submarines goes on. Every day, Electric Boat engineers are coming to grips with problems in nucleonics that pave the way for applications in other fields.

There is room — and opportunity — for more engineers able to cope with these problems. Current openings are for Mechanical Engineers with experience in vibration and shock, machine design, stress analysis, hydraulics, rotating machinery, power plants, or air-conditioning and piping.

These jobs offer more than engineering adventure. There's common-sense practicality involved, too. Electric Boat's backlog of orders and years-ahead plans; its record stable engineering employment; its sponsorship of advanced study at leading universities and within the plant are some of the practical features. New England living on the shores of Long Island Sound is another.

To find out more details about these opportunities, write us details of your background and experience including initial salary requirements. Interviews will be arranged promptly for qualified applicants. Please address **Peter Carpenter.**

ELECTRIC BOAT
DIVISION OF GENERAL DYNAMICS CORPORATION
GROTON, CONNECTICUT

Thomas B. Keenan, executive vice president, Plastic and Rubber Products Company, has been named chairman of the **O-ring Manufacture Sub-Division of the Rubber Manufacture Association, Inc., F. A. Lewis,** Linear, Inc., was named

Thomas B. Keenan
Plastic & Rubber Products Co.

vice chairman. Members of the executive committee include Thomas B. Keenan, R. E. Allen, Precision Rubber Products Corp., W. J. Johnson, Goshen Rubber, Inc., F. A. Lewis, T. J. McCuistian, Parker Appliance Co., and J. Strackbein, Albert Trostel Packings Ltd.

THE MARKET PLACE

DISTRIBUTORS or REPRESENTATIVES

wanted for several open territories on our line of quality valves, cylinders, valve actuators and pumps. Write giving lines handled and territory covered. Ledeen Mfg. Co., 1600 So. San Pedro St., Los Angeles 15, California.

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Sales engineer, graduate mechanical engineer with 13 years sales experience in hydraulic and air components field wants direct factory connection as manufacturer's representative on straight commission basis. Well-acquainted in Detroit and outstate. Box 1556 APPLIED HYDRAULICS.

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DEVELOPMENT ENGINEERS

Honeywell's Aeronautical Division is one of several Honeywell Divisions specializing in automatic controls. At Aero the main specialties are guidance and automatic flight control of missiles and aircraft, airborne instrumentation, airborne servomechanism components and jet engine controls.

■ Top development positions are open for aeronautical, mechanical and electrical engineers. This means complete design and development responsibility for components and systems in the field of autopilots, fuel measurement systems, inertial guidance systems, vertical and rate gyros, stabilization platforms, and many others.

■ As a design engineer you will provide technical direction for draftsmen, technicians, model makers and evaluation engineers essential to the project. An engineering degree or its equivalent plus practical experience with related or similar equipment is required.

CONSIDER THESE ADVANTAGES

■ Minneapolis, the city of lakes and parks, offers you metropolitan living in a suburban atmosphere. No commuting.

■ Your travel and family moving expenses paid.

■ Salaries, insurance-pension programs, plant and technical facilities are all first-rate.

■ Honeywell, leader in control systems, manufacturers of over 10,000 different products, offers unusual diversification and variety. A sound growth company, continually expanding, it offers permanent opportunity to you.

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If you are interested in a career at Honeywell, call collect or send your resume to Bruce Wood, Dept. HY-6-98, Aeronautical Division, 2600 Ridgway Road, Minneapolis 13.

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What's your problem?

- higher pumping speeds?
- tolerance of particle-laden liquids?
- peak suction for primary pumps?

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Is unmatched for dependable performance on every one of those counts.

Bulletin A-1330 has full data . . . write for it. The roller-rotor design easily handles particles that would jam more tightly-fitted mechanisms—reduces cavitation, allowing higher speed operation*—develops high suction characteristics.

*Roller mechanisms permit higher speeds with any oil than most displacement designs.

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385 Williams Ave., Hackensack, N.J.

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DEPENDABLE RELIEF VALVE
For Low Pressure 10 to 500 P.S.I. Oil

Designed For Continuous Operation

For systems where pressure is regulated by spilling over the relief valve.

- Long Life—hardened steel parts
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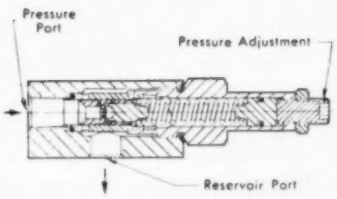
- Dependable—will not stick open



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Relief Valves • Check Valves • Restrictor Valves
Needle Valves • Pilot Check Valves • Special Valves
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RHOADS

New PACKING HANDBOOK

An invaluable reference for the design and application of packings

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VEE PACKING

FLANGE PACKING

CUP PACKING

Here it is, just off the press, Rhoads new 56 page handbook on the design and application of hydraulic and pneumatic leather packings!

Every subject from "What is a packing and how it is used" to "Maintenance of Packings" is thoroughly covered.

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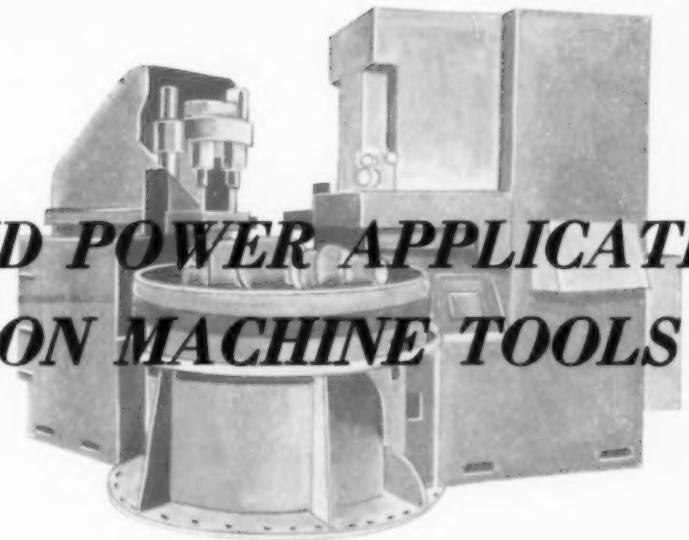

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